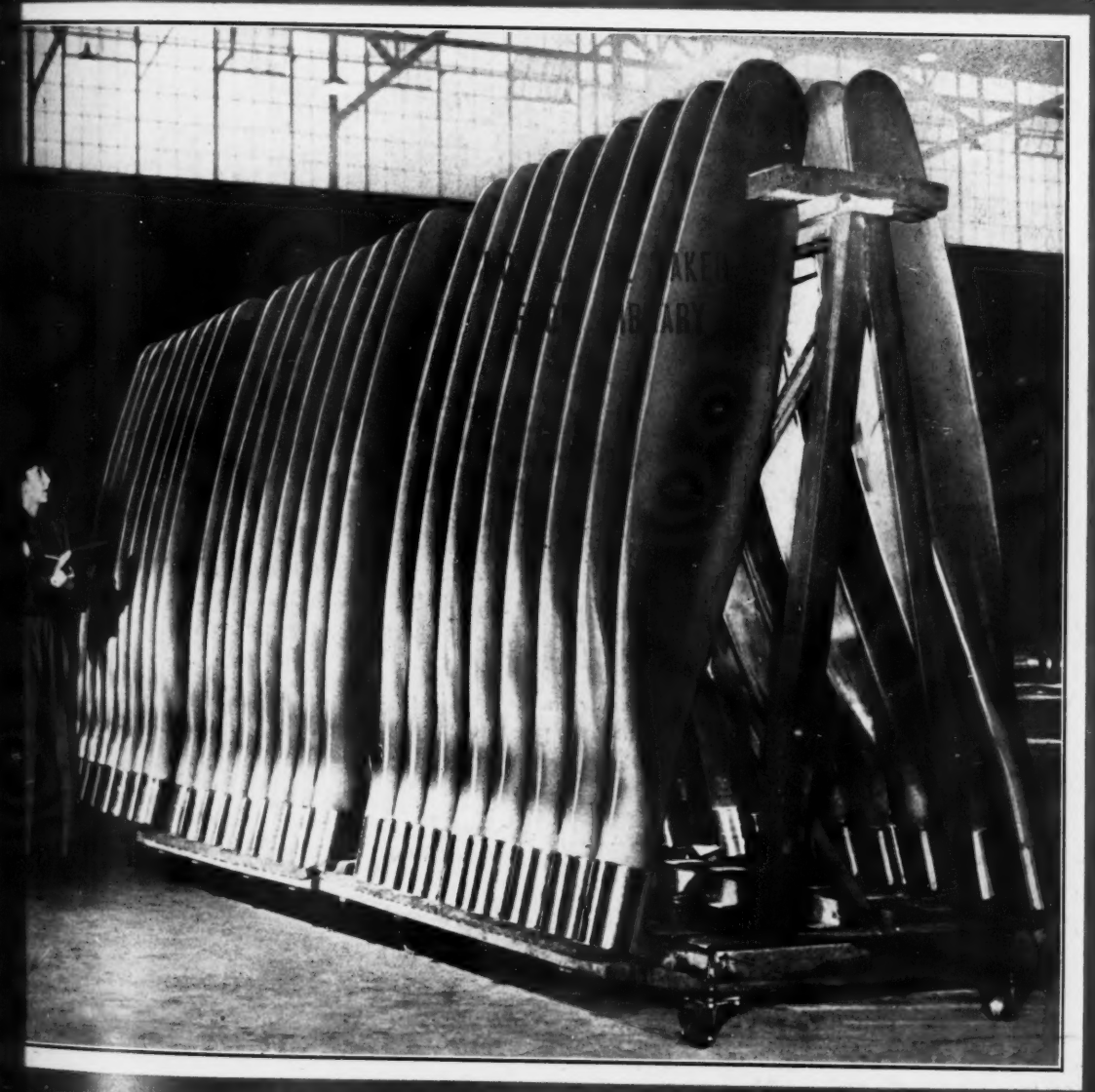
AERONAUTICAL ENGINEERING REVIEW

INSTITUTE OF THE AERONAUTICAL SCIENCES

APRIL 1943



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Trail Blazing in the Skies

1920

THE FIRST BULLET-PUNCTURE-SEALING GASOLINE TANK for military airplanes was developed by Goodyear at the close of World War I. After exhaustive tests it was adopted by the Army Air Corps and Goodyear was officially commended in 1920 for its invention. That is a matter of record, as was its effectiveness in sealing punctures made by the small-caliber armament then carried by planes.

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AVIATION INDUSTRY

1. *By building parts to manufacturers' specifications.*

2. *By designing parts for all types of planes.*

3. *By re-engineering parts for mass production.*

4. *By extending our research facilities to aid the solution of any design or construction problem.*

The Eleventh Annual Meeting of the Institute of the Aeronautical Sciences

ALEXANDER KLEMIN*
New York University

Introduction

THE ELEVENTH ANNUAL MEETING of the Institute was for the first time held simultaneously, January 25–29, 1943, in three centers—in New York City at Columbia University, in Detroit at the Rackham Educational Memorial, and in Los Angeles at the University of Southern California. The purpose of the three simultaneous meetings was to minimize travel by executives and engineers from important war jobs in the present emergency. The same program was offered at all three centers, papers sometimes being presented by proxies—experts in the same field as far as possible. A total of over 1,500 persons attended the meetings.

Papers were restricted more to analysis and technology; information as to the latest design or production features of current aircraft or engines was naturally withheld. Limited discussion was permitted. Papers for some of the sessions were made available for presentation only and therefore have not been reviewed in this article.

Requests for any preprints or reprints of papers mentioned should be made directly to the authors and not to the Institute.

Aerodynamics

Aspect Ratio Corrections

The aerodynamic papers were solidly informative and of high technical standing. Prof. K. D. Wood, of Purdue University, discussed the subject of *Aspect Ratio Corrections*. While aspect ratio corrections for most normal conditions and for normal aspect ratios are well founded, they can be in error by as much as 30 per cent for aspect ratios of 1.5 or less. By a systematic study of all available experimentation to date and by a new system of plotting, a method of low aspect ratio correction was developed which is much nearer to the truth. Professor Wood also introduced a new method of estimating the airplane efficiency factor e used in aspect ratio corrections for induced drag, taking into account the size and shape of the fuselage as well as the aspect ratio. A definite example of estimating e was presented in the paper. While the paper covered no new ground fundamentally, it will be of real value in engineering office computations of performance.

Maneuverability

John E. Goode, Jr., of Douglas Aircraft Company, discussed *Maneuverability Criteria Through Turning Performance*. (This paper was printed in full in the March issue of the JOURNAL —ED.)

Flutter

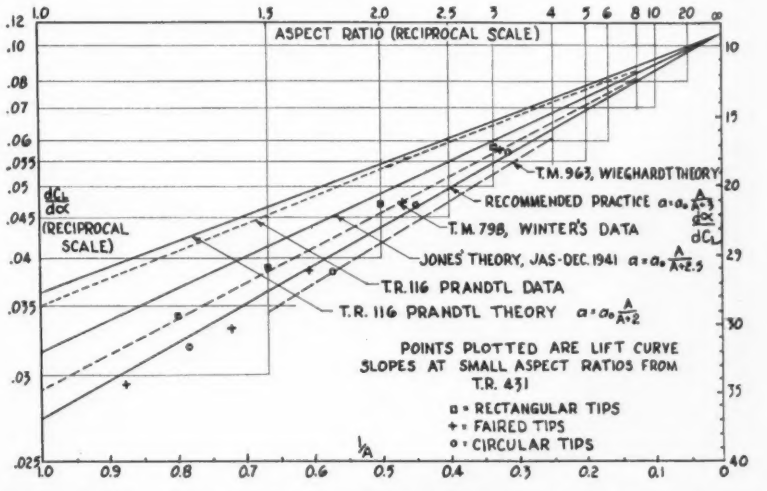
Zbigniew Krzywoblocki, of the Polytechnic Institute of Brooklyn, presented a paper on *Torsional and Aileron Flutter*. The aim of his paper was to find an approximate solution for the influence of various elements on the critical frequency in the binary system of torsional and aileron vibration. The theory of complex airplane vibration is fairly well developed. The difficulty always is to disentangle the complex effects of each element. In this paper certain simplifying assumptions had to be made. For example, damping was not taken into account. Certain other assumptions were made which may perhaps be open to criticism both from an aerodynamic and mathematical point of view. Nevertheless, the author's conclusions are of value and are offered here textually:

"(1) With regard to the influence of the kind of material on the binary system of torsional and aileron vibration, the decisive factor is the ratio of modulus of rigidity to the specific weight. High values of this ratio for steel and magnesium alloys were obtained—the lowest for wood.

"(2) The influence of span and airfoil thickness is significant, less the influence of wing taper.

"(3) When a tubular member consists of various materials, the decisive factor is also the ratio of the modulus of rigidity to the specific weight. The following combinations might be advantageous: aluminum alloy or magnesium alloy wing and steel aileron, spruce-plywood wing and metal aileron.

"(4) Three different ways lead to the same result—that, from a system of torsional oscillation standpoint, the decisive factor is the ratio of the



Comparison of theory and experiments on slope of lift curves of wings of various aspect ratios. (From *Aspect Ratio Corrections*.)

* Guggenheim Research Professor of Aeronautics.

ELASTIC STRETCH

THERMAL CHANGES

Two Control Cord Factors that call for LOCK-CLAD

ENGINEERING for optimum performance at today's altitudes calls for a full recognition of the effects of cord stretch and temperature changes on the functioning of the control system.

Elastic stretch of conventional control cord, varying, of course, according to load and cord diameter, can reduce the efficiency of a carefully-rigged control system. (A 1000 lb. load on a 3/16", 7 x 19 cable, for example, results in a stretch of .372% of the cord's length.)

In addition, the factor of difference in coefficient of expansion between the control cord and the dural structural airframe members must be considered. An aircraft control system rigged at sea level temperature may become much less efficient at 30,000 feet due to these thermal changes.

Lock-Clad Control Cable minimizes both of these effects, especially on large aircraft where long cable lengths tend to aggravate the problem. It is available from Roebling in lengths and sizes to specifications, and may also be supplied with swaged terminals as complete assemblies, ready for installation. For further information, write the Roebling Engineering Staff.

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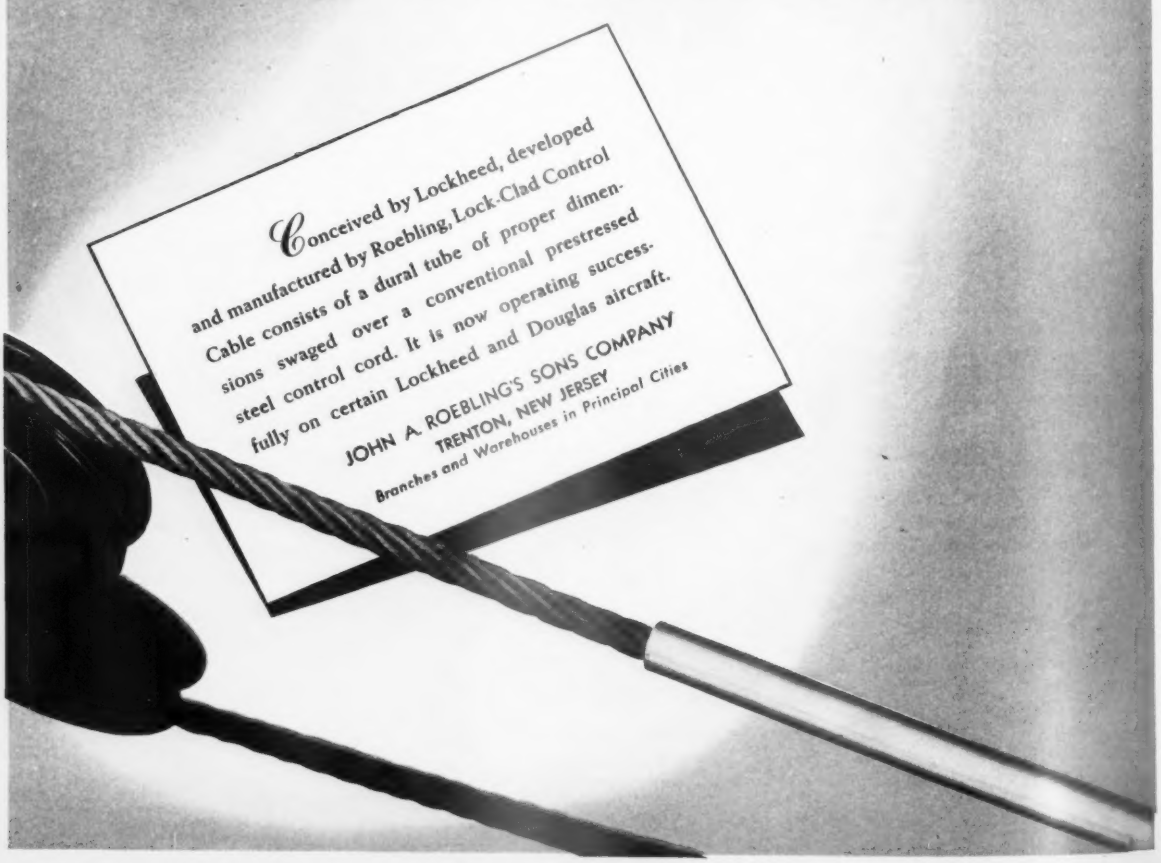
AIRCRAFT WIRES AND TERMINALS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Cable consists of a dural tube of proper dimen-
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modulus of rigidity to the specific weight—namely, the computations grounded on the greatness of the torsional frequency given by von Kármán and Biot, the differential equation grounded on Newton's Law and Rayleigh's Method.

"(5) The obtained results cannot be applied directly in practice because damping, an important factor from wing flutter point of view, was not taken into account."

Airfoil Characteristics

In the designs of turbines, superchargers, hydraulic machinery and the like there arises the problem of behavior of airfoils in grid arrangement. There is a great amount of literature available on multiple grid airfoils, but there is considerable doubt that the theoretic results can be used without correction in the design of axial flow fans, compressors, and turbines. In particular, information is lacking on the behavior of a single airfoil while in the presence of the grid. Prof. John R. Weske and F. E. Marble made an experimental setup and reported on it in a paper entitled *Characteristics of Airfoils in a Cylindric Axial Flow Grid.* An airfoil grid is arranged on a wheel that is mounted in a wind tunnel with the appropriate boss or hub at the center. The cylindrical axial flow grid is so set up as to satisfy the requirements of an infinitely long grid. A motor is provided to give the grid various rotational velocities as compared with the velocity of the wind tunnel. Pressure distribution for a single airfoil can be obtained during runs by a special pressure-indicating mechanism. The experimental technique is of interest. The following conclusions were drawn by the author:

"(1) For wide spacing of the blades pitch chord $t/C = 11$ the lift coefficient C_L increases linearly with angle of attack.

"(2) The zero lift chord appears to be the same for the various pitch chord ratios tested.

"(3) For grids of narrow spacing the lift coefficient decreases for a given angle of attack, its variation with angle of attack is no longer linear, and its stalling characteristics are less critical than at wide spacing."

The Towed Glider

Aerodynamic Problems of the Towed Glider were discussed by Alexander Klemin, of New York University, and W. C. Walling, of Lockheed Aircraft Corporation. Certain theories of the combined tug and towed glider were worked out. Then systematic calculations were carried out for the performance range and pay load of the airplane and the towed glider. The authors came to the conclusion that the tug or powered airplane had to be specifically designed for service in the glider train. The tug should be capable of delivering tremendous thrust horsepower while being of relatively small dimensions. It should be provided with a power-plant system efficient when the power extracted from the power plant is only a fraction of the maximum power obtainable. In this manner flexibility of operation could be obtained. Thus, when little load is to be carried, the tug would fly alone and employ little power. When great cargo loads have to be transported, the tug would pull one or two or even three gliders. Besides the difficulties of control, the towing of gliders naturally brings down the cruising speed considerably and also decreases the maximum range. For a constant speed range, however, a glider train can be made to give a far greater pay load than conventional transport airplanes of today. The pay load might be multiplied by five when the cruising speed is still well above stall. The advantages of the glider train might, however, be overestimated, since first of all a large transport airplane specifically designed for carrying large cargo could readily be made to equal or even surpass the performance of the glider train. Again, because operation in commercial work varies inversely with the block speed in the glider train, the apparent advantage of greater pay load might be more than counteracted by the penalty due to low block speed. The glider train would probably find its best application in carrying huge loads for relatively short distances.

Aircraft Production

This is the first time that a session devoted exclusively to aircraft production has been present on the program of the Institute.

Economic Problems

G. M. Giannini, of Vega Aircraft Corporation, the first speaker in the session, dealt with *The Economic Transition of Aircraft Production.* He discussed not only present problems of airplane production but reviewed the progress as a whole in the last few years. Improved tooling has resulted in better interchangeability of parts and assemblies and closer tolerances. Yet, in spite of increased tool quality, tooling costs as a whole have decreased during the last six years from an average of 5 to 10 per cent of contract cost to as low as 1 to 4 per cent in current production. Fabrication methods have greatly benefited by increased contract size, and there has come development of new forming techniques and highly efficient specialized materials. Fabrication costs per pound of air frame have been reduced to two-thirds of the corresponding costs for equal quantities a few years ago. The progressive assembly system and sectional assembly system have greatly improved assembly technique. In the progressive assembly system a structural fuselage is built and equipment is installed on it in successive stations. This lends itself to the manufacture of small and medium-sized airplanes. In the sectional assembly system a geometric section of the air frame is completely assembled with all equipment finally intended for it, and the completed sections are then joined together. This type of assembly has proved better for large airplanes. The extraordinary thing is that, while in the automobile the cost per pound does not vary so much from vehicle to vehicle, in the cost of the airplane the variation is extremely high. Naturally complex military machines are likely to cost much more for given weight than the small commercial aircraft. Some interesting charts in regard to the reduction of overhead costs were given which also explained why larger aircraft results in decreasing cost. While this may not appear to be of importance in wartime, decreased costs mean decreased labor, which is important in wartime.

Aircraft Plywood

One of the oldest materials of aircraft construction—namely, plywood, has undergone a tremendous revival. It was appropriate, therefore, that Thomas D. Perry, of the Resinous Products and Chemical Company, should present a review of *Progress in Aircraft Plywood, 1941–1942.* (This paper was printed in full in the February issue of this magazine—Ed.)

Lofting

Tremendous improvements have been made in lofting, which was used for centuries in shipbuilding but only entered aircraft fabrication quite recently. The aircraft industry has taken the lofting technique and has used it for its primary important function of speedily transmitting engineering information to the production shops. Yet in many factories the fundamental factors of simplicity of lofting and engineering technique have been lost sight of because no

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No use tinkering with up-to-the-minute brakes

Marine scout plane moves toward forest-concealed hangar in South Sea tropical jungle.

Official U. S. Marine Corps Photo

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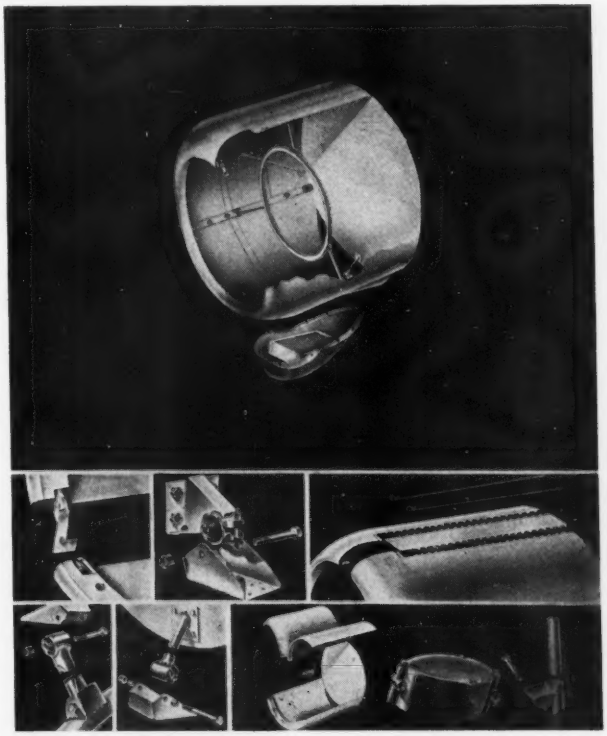
duplication process was available and cumbersome procedures for sheet metal lofting have followed. Philip Taber, of Brewster Aeronautical Corporation, presented a paper on *Photoprint Reproductions in Aircraft Lofting*, which shows how this one difficulty in aircraft production has been removed. The photoprint process is well defined by the author:

"It is a photographic process in the strict sense of the word but is unique in that it uses no camera equipment or lenses of any sort. It employs the principle of reflection and contact exposing of positive and negative materials having high contrast properties. Development and fixing follow regular photographic practice. It reproduces any original from a clear engineering layout to a marred and scratched template that has seen shop abuse. The copies it makes are distinct without bleeding or broadening of lines. The lines are black on a white background for a left-hand reproduction or white on a black background for the opposite hand. This latter reproduction, white on black, results when an assembly is symmetric about the reference lines, and only one hand is laid out manually, the other being photoprinted and reproduced. The surface of the photoprints is excellent for drafting.

"Reflection exposure as used in the photoprint process is employed as follows: The layout or the subject to be duplicated is brought face to face with the emulsion side of the negative material. Light for exposing the negative passes through the negative material and is reflected back from the surface of the subject. The principle is that dark surfaces absorb light and light surfaces reflect it, resulting in the differential exposure of the negatives. When a positive is required it is made by the conventional contact printing method. Here light passes through the negative to the sensitized surface of the positive, the dark surfaces screening out the light and the light or translucent surfaces allowing the passage."

A number of advantages follow. All line work, structural layout, template and tool work derive from the same negative. Duplication is exact as only contact photography can be. Engineering becomes more closely tied up with tooling and production. Inspection is simplified to checking filed surfaces since there are no errors resulting from hand copying. Tooling is made cheaply and quickly for sheet metal parts by means of form block, marking, blank and pierce and overpress drill and trim templates. Production is facilitated by having the parts completely proved prior to release, and larger runs can be released to the shop. Template manufacturing is made more rapid and accurate.



Group of drawings giving detailed information required for the assembly and the installation or removal of engine cowling. (From *Perspective Illustration as Applied to Aircraft Design and Production.*)

Perspective Illustration

Perspective Illustration as Applied to Aircraft Design and Production by Arthur M. Fitzpatrick, of the Stinson Aircraft Division of Vultee Aircraft, Inc., indicates that perspective illustration has now definitely taken its part in aircraft construction. Primarily perspective illustration came into being when unskilled labor had to be employed in aircraft plants. It has now been found that perspective illustration can be made to facilitate construction even in plants with experienced mechanics. It can also be employed in drafting offices as a valuable aid to visualization of difficult problems.

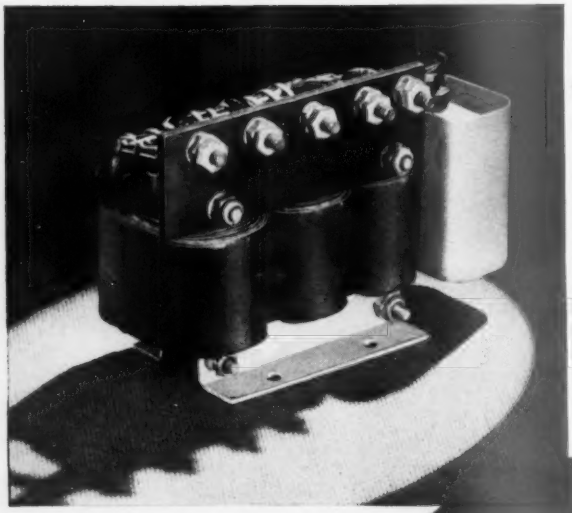
Magnesium Alloy Sheet

Magnesium, with its remarkable properties, has finally come into its own. C. E. Lehnhardt, of The Dow Chemical Company (*The Plastic Working of Magnesium-Alloy Sheet*), pointed out that prior to the advent of present aircraft production requirements magnesium alloys were used mostly in the form of castings, flat sheet, and extruded shapes. Sheet deformation was done for wooden forms by means of a rawhide hammer and heating torch. Line bends were accomplished in either a press-type brake or folding-type brake with heat applied to the sheet by means of a torch. Present production requirements have widened the use of press and die equipment suitably designed to accomplish the required deformation. Experience gained thereby has indicated the possibility of manufacturing parts formerly thought to be either too costly or impossible in magnesium. This experience plus the development of improved alloys has now enabled manufacturers of aircraft parts to take increased advantage of high strength-low weight ratio magnesium alloys. Metallurgic development and improved fabrication methods have kept pace. The author gives a full and practical account of these improved methods of forming of magnesium-alloy sheet material. The equipment described is in the form of either hydraulic or mechanical presses. Bending may be either in the leaf-type or press-type brake. Blanking tools, drawing dies, drawing lubricants, cleaning mediums, fabrication methods have all been vastly improved and are fully dealt with by the author. There has been surprising development in deep-drawing magnesium alloys. The author gave as his opinion: that new alloying and fabricating processes will open up even

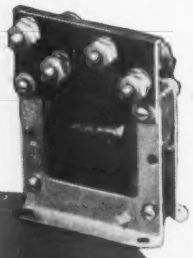
NEW

G-E TRANSFORMERS FOR COMBAT

These Compact Units Save Space and Weight



3-phase to 1-phase transformer—for the operation of such auxiliaries as the radio compass, bomb indicator lights, indicator rim lights. Eliminates the need for a single-phase winding on the generator. Permits reduction of generator weight; increases efficiency. Provides a single-phase, 115-volt or 26-volt power supply from a three-phase, 400-cycle generator *without disturbing generator phase voltages.* Ratings from 50 to 250 va. Weighs only $2\frac{3}{8}$ lb; size $3\frac{9}{16}$ by $5\frac{5}{32}$ by $2\frac{5}{16}$ in. (Weight and dimensions are for 150-volt-ampere rating.)



Indicator-light autotransformer—to provide a 30-va, 3.0/1.5-volt supply for bomb indicator lamps. Each unit will operate fifty-two 0.19-amp, T-$1\frac{1}{4}$ lamps. A 1.5-volt tap is provided for dimming the indicator lights, making possible the reduction of excessive brilliance in cockpit lighting when desirable, and the prevention of premature lamp failure due to overvoltage when only some of the lamps are lighted. Two ratings available for operation from a 115-volt or 26-volt, 400-cycle, single-phase supply. Weighs only $13\frac{1}{2}$ oz; size approximately $2\frac{1}{4}$ by $3\frac{1}{4}$ by $1\frac{1}{2}$ in. Adaptable to many other indicator lighting applications.

Enclosed ballast—for fluorescent lighting of aircraft instrument panels. Will operate four 4-watt MAZDA F lamps from a 26-volt, 400-cycle power supply. Lightweight (2.10 lb) and small size ($3\frac{1}{2}$ by $6\frac{1}{2}$ by 2 in.) make this unit particularly suitable. Designed for operation at any altitude and in ambient temperatures up to 60 C. Similar units are available for operation from a 400-cycle, 110-volt supply, and in addition provide a 3-volt, 10-amp (or 5-amp) supply for indicator and instrument rim lighting by means of a small transformer within the same housing.

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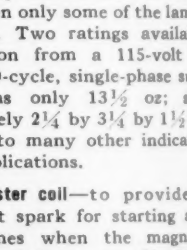
Inverter ballast (d-c to a-c)—for fluorescent lighting of aircraft instruments and indicators on training or other light planes. Operates four 4-watt MAZDA F lamps from a 12-volt or 24-volt d-c battery supply. Also provides 1.5 amperes for operation of eight 3-volt indicator lights. A low radio-interference level is obtained by the well-balanced electrical characteristics of the windings and by careful filtering. For operation up to 35,000 ft and in ambient temperatures from −15 F to 140 F. Weighs only $2\frac{1}{2}$ lb; size $5\frac{1}{8}$ by $5\frac{5}{8}$ by $4\frac{7}{32}$ in.

Yours for the Asking — *Complete data on how to do the job better by using transformers. Write for a copy of "Specialty Transformers for Aircraft." General Electric, Section C403-41, Schenectady, N. Y.*



GENERAL ELECTRIC

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greater fields for magnesium and that they can now be used fully, provided the designer and press shop men will supplement their knowledge of forming operations and the techniques necessary. The paper is one that deserves to be studied by every designer and shop man in the aircraft industry intrigued with the possibilities of this remarkable material.

Aircraft Design

Comfortization

In the early stages of military aircraft design it was thought sufficient to provide a pilot with an open cockpit and a gun. Experience has proved that the comfort of the aircraft crew is an important element in all military and naval operations. *Comfortization of Military Aircraft* by Albert A. Arnhym, of the Pacific-Airmax Corporation, was accordingly a timely message to aircraft designers. It was pointed out that "comfortization" owes its existence to commercial considerations but now has taken its full place in military design. Comfortization means the removal or study of (1) noise, (2) ventilation, (3) bumpiness, (4) heat or cold, (5) improper seating, (6) mechanical vibration, (7) rate of climb or descent, (8) altitude factors, and (9) smell. All these apply in military design. For military purposes there are additional requirements. Means must be provided to meet emergencies such as large holes torn in sealed cabins by enemy fire, damage to oxygen supply, and parachute jumps from great altitudes. Heating becomes a separate accessory group. Combat comfort also includes suitable design and arrangements of sight, gun handling mechanisms, and other factors that eliminate or minimize unnecessary strain on the eyes, nerves, or body. Again, there must be some reasonable protection against enemy fire for the flight crew.

In the plane itself, emergency aids after combat must be available. Parachutes, life rafts, and similar devices become indispensable. Proper lighting for maps and instruments is all important in long-range operations. The author believes also that in military aircraft there should be no crawling over narrow catwalks and high steps of bulkheads when the crew are already burdened with bulky equipment. Cabin heating of military aircraft is no longer considered an unnecessary luxury. Deicing must be replaced by anti-icing methods. Heating in flight must be supplemented by ground heating because fighters and interceptors may have to take off at a moment's notice with stone cold engines and accessories. Methods of heat supply were discussed in detail. Undoubtedly, comfortization has become an important element of military airplane design.

Protective Armoring

It was quite appropriate that a companion paper be *Passive Defense —The Protective Armoring of Military Aircraft* by Horace J. Alter, Consulting Engineer. The paper was illustrated by sketches that vividly bring out the author's points. Space will not permit a detailed discussion of the paper. One quotation, however, is appended which typically illustrates the author's approach to the subject and indicates the placement of armor which he advocates for protection of combat crews:

"Primary consideration should be given to the crew members when determining the location of armor plate. Personnel located in the nose should be protected against direct fire by heavy plate with lighter wings or side shields to protect against side fire. By putting the plate close to the individual to be protected, the area of plate can be reduced to approximately 8 sq.ft. for full protection. Careful placement of equipment such as the nose wheel, instruments, and auxiliary equipment such as electrical boxes will also serve to protect any member of the crew located forward. The installation of heavy armor plate at the rear of the spinner on a single-place pursuit serves as protection for the engine and pilot at the same time. Bullet-resistant glass in the windshield will protect the face and chest of the pilot. The installation of leak-proof fuel and oil tanks in front or behind the pilot also provides additional protection. The single-seat pursuit is protected against fire from the rear in the same manner as flight crew members on multiplace fighters, with the exception that single-place pursuits must also provide armor plate protection for the pilot's seat and legs, since there is rarely enough protection provided by adjacent equipment as is the case for the larger airplane. . . . .

"Personnel in the flight station (pilot, copilot) and those in compartments adjacent to the flight station require protection against forward gunfire and fire from the rear. . . . . Bullet-resistant glass and aluminum-alloy plates may be used to protect the face and upper parts of the body against forward gunfire. Protection against gunfire from the upper sector of the rear cone should be heavy armor plate. . . . . The upper plate may be welded to a lower plate of lighter gauge which protects the body from the region of the lungs down to the bottom of the seat. Light plate may be used for the lower part, since any bullets striking in this area are likely to have passed through other portions of the structure and lost some of the energy and penetrative power. Protection against gunfire from the lower sector of the cone may be provided by equipment, fuel tanks, wheels, tires, and structure. Heavy aluminum-alloy sheet may be used for skin, at the same time serving as deflector plates for both crew members and vital equipment. The flight station, being adjacent to the engine nacelles, is usually protected

Cabin of the Curtiss Condor of 1930 showing an early heating and soundproofing installation. (From *Comfortization of Military Aircraft.*)

"SEVENTY BELOW"

. . . . IS TOUGH ON HOSE LINES

AEROQUIP has met the low temperature challenge. First, in the factory, then in the field. In our own laboratory, we researched this problem at temperatures as low as —70° F.

At (censored), combat planes were grounded for winterization. Aeroquip met this sub-zero challenge with new Aeroquip low-temperature hose and Aeroquip detachable hose fittings. Planes were fitted with new hose lines tailored on the spot—a fast, emergency field service which sent them back into fighting service without delay.

Aeroquip detachable hose fittings simplify field base replacements by reducing the thousands of combinations of sizes and lengths of hose lines to dozens of fittings and sizes of hose. These detachable hose fittings are instantly re-usable with new Aeroquip hose for hose line repairs. These are fighting advantages for our air forces.

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against side fire by the wing and engine groups. However, in the single-place pursuit with one engine, side protection must be provided. It is usually sufficient to extend the back plate or place equipment at the sides for protection.

"Protection of crew members in the aft portion of the airplane against lateral fire is most valuable in the form of flexibly mounted plates. Side and waist gunners, who are usually the ones to be protected, are likely to need protection in the direction in which they are firing. Flexibly mounted plates require less area to protect than fixed plates because of the fact that the gunners are moving about, thus requiring coverage over large areas if fixed plates are used. Again, good judgment in placing the armor plate will enable the plates to be used for protecting guns, ammunition, and equipment as well as personnel. Side plates for gunners should be of light steel and provide protection from the head to the crotch.

"Splatter shields, in the form of aluminum-alloy angles or splatter preventive coverings, should be attached to all armor plates to keep the shattered bullet from injuring personnel or tearing holes in adjacent structure and equipment. Considerable damage may be done to pipe lines, control cables, and electric wiring by bullet splatter if uncontrolled. Plastic or plywood coverings may be used as an absorbent to prevent dispersion of the bullet fragments."

X-Ray Testing

In discussing the paper by L. W. Ball, of Triplett and Barton, Inc., *The Relation of X-Ray Testing to Aircraft Design*, the technique of radiography itself will not be dealt with but only with the author's reply to the question that he himself raises: "What sort of service should aircraft engineers demand from the radiographer?" To this question he gives the answers under three headings: (1) Complex structural or engine parts produced by casting or forging; (2) uniform sections, such as sheet produced by rolling or tubes produced by extrusion; and (3) built-up sections produced by welding, spot welding, or riveting together of stock material:

"(1) In castings radiographers of previous castings should be examined. Defects should be analyzed. Radiography can be brought into use to examine castings by having the radiographer present so that familiarity with the molding, degassing and pouring practice can help to make his interpretation of the radiographs more valuable.

(2) X-ray inspection can be made to assure uniformity of the material and to indicate chemical segregation or cavities in the original billet. It would permit the engineer to select test bars from sections that are probably weakest.

"(3) The use of radiography to test welded junctions between steel tubes is well known. It ensures that production joints that cannot be tested to destruction are as good as sample joints whose strength has been tested. Radiography can be used to develop the welding process by giving a rapid account of the effect of changes in the electrodes or flame temperature, etc. The skill of the individual welder is most rapidly improved where radiographs are used to show him the effect of variations in procedure and to check the results of his own work. Control of spot welding results by x-ray investigations is particularly interesting in that it involves defects and chemical segregation on a microscopic scale. In this case, radiography is a valuable supplement to metallography."

Designing Aerodynamic Surfaces

John J. Apalategui, of Douglas Aircraft Company, Inc., in his paper *Designing Aerodynamic Surfaces by the Use of Algebraic and Trigonometric Functions to Permit Easy Manufacture* was concerned with the analytic methods used for the development of the external shapes of aerodynamic bodies. Mathematical methods of surface description are presented by the author involving well-known methods of conic sections with equations of five arbitrary points used to define conic curve. With the use of these conic methods an equation may be set up—for example, for an elevator nose shape to hold a given radius of curvature at the leading edge having certain valuations and to become tangential to a straight trailing edge with an infinite radius of curvature. Readers must, of course, refer to the paper itself for these mathematical methods of lofting, laying out and the like. It may be asked what are the advantages of this mathematical approach? One advantage is greater precision with accompanying benefits of interchangeability and standardization. Only when the shape of the body has been defined with mathematical precision is it possible to obtain precision in manufacture. Subsequently, tables of offsets help in the production of loft board and plaster patterns used for cowl, ducts, fillets, and other complex shapes. It is true that many structures are so complex that only description by joint and offsets is possible, but a surprising complexity of shapes can be defined by mathematical formula. Particularly when curves become too large for ordinary layout methods, it is more satisfactory to write curve sections and lay out shapes from calculated offsets. By the use of mathematical control for the entire external surface of fuselage or hull it becomes unnecessary to make board or template in the layout larger than the largest piece of frame or sheet of skin which will be used on the fabricated assembly.

Air Transport

Pressurized Cabins

Opinion with regard to the necessity of pressurizing in commercial aircraft has swung from one side to another. At first, pressurizing of the passenger cabin was regarded as one great development necessary in passenger travel. Then when experience indicated that pressurized cabins meant greater cost of operation and lowered economic possibilities, the pendulum swung to opposition. Now opinion seems to be again that pressurized cabins will have to come on almost all our transport aircraft. Therefore the paper by Charles W. Morris, of Airesearch Manufacturing Company, *Pressurizing Low-Altitude Airplanes* may be regarded as timely and important. On the basis of a survey the author is of the opinion that the greatest current objection to air travel is the changing air pressures that occur when the airplane climbs or descends. As a result of these studies he comes to the definite conclusion that the airplane cabin should be pressurized to sea level conditions or to airport altitude. Further, cabins should be provided with means for gradually changing cabin pressure between airports located at different altitudes. Such improvements would eliminate the major cause of plugged ears, earache, stomach and intestinal gas, artificial sleepiness, and dizziness in air passages. A detailed discussion in the paper of objections to unpressurized air travel seems to make it quite clear that we should have pressurized cabins. The greatest passenger comfort will be realized by keeping the total pressure changes as low as possible and at the same time as gradual as possible. During take-off and initial climb period the cabin would remain at sea-level pressure. Then the rate of change selector would be set to give the total change in cabin level required during the flight. Prob-

ably the selection of pressurization would be changed on different parts of the trip. The author is of the opinion that the compressor problem would not be a difficult one, since the maximum pressure ratio required of the compressor would be less than 2 for maintaining 6 lbs. per sq.in. cabin differential pressure while flying at 20,000 ft. Heating of the cabin air during cold weather would be accomplished through utilization of the energy of compression. Cooling the cabin during warm weather operations might also be tied up with cabin supercharging cycle.

Long-Range Air Transport

William M. Masland, of Pan American Airways System, took as the title of his paper *Developing Maximum Efficiency in the Operation of Long-Range Air Transports.* There is no one method or device for attaining such efficiency, but many aspects of the problem were covered. Of course, he is for the moment giving more weight to military operation than to peacetime operation. The author has drawn largely on his experience in development of airways for military purposes. There must be, above all, adequate space for cargo and fueling. Servicing of undeveloped routes may be accomplished by flight engineers by using equipment carried on the ship. This, of course, increases the size of the crew. Adequate crew size is indispensable. Four members in the crew are normally detailed for piloting on long flights. Two men can conceivably fly a ship but, because of greater fatigue, they may not be able to fly it with the same precision as four. A large ship climbed carelessly to 8,000 ft. might consume 74 gal. more fuel than the same ship climbed with precision. The author points out that on a crossing of the South Atlantic two flight engineers would save several times their weight in fuel by their ability to concentrate all their energy on the engine. Discussing the length of service in long-range operations, the author believes that the trick of sleeping at irregular hours is indispensable and can be acquired with practice. Working conditions must be improved, particularly with regard to space. Crews should be frequently changed. Space will not permit discussing the paper in more detail. It should, however, be of great interest to those concerned with long-range operations today.

Air-Line Operation

Dixon Speas, of American Airlines, Inc., in his paper on *Engineering of Power Control and Altitude Selection in Air-Line Operation* has dealt exhaustively with the problem of selecting the best horsepower and the best altitude from the point of view of commercial costs and efficiency. He describes in particular an instrument entitled altitude selector and flight-plan analyzer, which is greatly helpful in flight planning. Other topics dealt with are an air-speed calculator chart and ground-speed calculator. Various slides presented variation of fuel costs with power, variation of flight crew costs with power, variation of depreciation costs with power, and the like. Direct flying cost versus cruising horsepower is shown in one of the slides. Apparently in engineering operation of air lines there is an immense problem in differential calculus in that so many factors covered with purely mathematical methods fail. The author's analysis of this particular problem in maximum and minimum illuminates this problem greatly.

Summary of Direct Flying Costs

(From *Engineering of Power Control and Altitude Selection in Air-Line Operation*)

		Cruising Horsepower				
		700	650	600	550	500
(A)	Crew expenses—cents/mile	8.49	8.79	9.13	9.49	9.91
(B)	Fuel—cents/mile	8.28	7.34	6.78	6.49	6.20
(C)	Depreciation—cents/mile	5.20	5.36	5.55	5.75	5.97
(D)	Passenger supplies and expenses—cents/mile	2.09	2.17	2.25	2.34	2.44
(E)	Insurance—cents/mile	0.85	0.88	0.91	0.95	0.99
(F)	Aircraft and radio maintenance and overhaul—cents/mile	3.67	3.80	3.95	4.11	4.29
(G)	Engine maintenance and overhaul—cents/mile	3.78	3.78	3.78	3.78	3.78
(H)	Miscellaneous—cents/mile	0.54	0.54	0.54	0.54	0.54
	Total—cents/mile	32.90	32.66	32.89	33.45	34.12

Materials

Design for Strength

A new method of reinforcing sheet metal, "design strengthening" as it is called, is accomplished by passing sheet and strip through specially prepared rolls. These rolls have on their surface a raised pattern that is transferred either to top or bottom surface of the flat sheet or to both surfaces. The patterns are designed to improve characteristics of the sheet such as stiffness, buckling strength, etc. The paper by Richard S. Smith, of the Rigid-Tex Corporation, and Hamilton Gray, of New York University, *Design-Strengthened Sheet Metal*, presented a number of such patterns. The conclusions of tests on stainless steel and aluminum alloy were: design strengthening has no significant effect on the tensile property; design strengthening does produce, however, an increase in proportional limits and yield strength of cylindrical specimens in longitudinal and transverse compression. Some increase in flexural rigidity (*EI*) was also noted in some of the tests. While none of the effects were extraordinarily high, they were sufficiently marked for the process to be of interest to designers.

German Aircraft

Of recent years there has been shipped to this country a number of German aircraft whose design features have been carefully analyzed in a number of ways. The examinations revealed among other things that German aircraft use a good deal more magnesium than do American aircraft. The paper by H. W. Schmidt, of The Dow Chemical Company, *Use of Magnesium in German Aircraft*, dealt with these captured German planes, especially from the point of view of magnesium utilization, and the author came to the following rather interesting conclusions:

"(1) Magnesium parts on the airplanes were found as sand castings, die castings, forgings, extrusions, and sheet.

"(2) The compositions used were magnesium-aluminum-manganese-zinc and magnesium-manganese types similar to those used in the United States.

"(3) Contrary to American practice of using most castings in the heat-treated condition, the Germans used a high percentage of the castings in the as-cast condition.

"(4) The more important castings were used in the heat-treated condition.

"(5) No serious corrosion was observed in spite of the fact that the basic corrosion resistance of the metal, as well as the protection afforded, were inferior to American practice.

"(6) Only a small amount of extrusion and sheet applications were found.

"(7) Of special interest is the rather extensive use of forgings. The more

The B.F. Goodrich Airplane of the month

CESSNA BOBCAT

WINGED UNIVERSITY. Many of the skilled pilots who will bomb the Axis tonight received their first Twin Engined instructions in Cessna Bobcat AT17 Bomber Pilot Trainers. This sturdy ship, used by both the United States Army Air Forces and the Royal Canadian Air Forces, has earned an enviable reputation for excellent flight characteristics combined with high serviceability. The many B. F. Goodrich products, including famed Silvertown Tires used by Cessna, have contributed to this fine record. This month B. F. Goodrich salutes the Cessna Bobcat, a great plane with a fine record on training fields throughout North America.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

B.F. GOODRICH RUBBER RESEARCH FOR THE *Aviation industry*

Smooth Contour Tires for today's faster-landing military aircraft

TODAY'S WARPLANES are landing at greatly increased speeds. They're landing on military airfields . . . often short, often rough, often muddy . . . and they're coming in safely. That's because improvements in landing equipment have kept pace with increased need for safer ground control.

B. F. Goodrich has played an important part in improving warplane ground control by the development of Smooth Contour Silvertown Tires. In addition to giving the same excellent performance and endurance for which B. F. Goodrich Low Pressure Silvertowns are famous, these new tires meet two other basic needs of fast-landing warplanes:

MAXIMUM BRAKING: When warplanes come in fast on short, rough fields, they have to be able to stop quickly. And they *do* stop quickly when B. F. Goodrich Smooth Contour Silvertowns are used on wheels equipped with Expander Tube Brakes.

These brakes expand radially against the entire inner surface of the brake drums. The B. F. Goodrich Smooth Contour Silvertown was specially designed with a large bead diameter which permits the use of larger wheel rims and consequently larger brake drums. This, in turn, increases the braking surface and the grip of Expander Tube Brakes so that they can stop fast-landing warplanes quickly.

MAXIMUM GROUND CONTACT: Warplanes must be able to maneuver fast on the ground, too, without the danger of skidding. B. F. Goodrich Smooth Contour Silvertowns have *a wide footprint* and non-skid tread which meet the need for maximum ground contact and stability.

Right now, the B. F. Goodrich Smooth Contour Silvertown is proving its worth on world battlefronts. It is filling the need for safer ground control at high speeds. And it's just one more reason why leading aircraft manufacturers specify with confidence, "B. F. Goodrich Aviation Equipment."

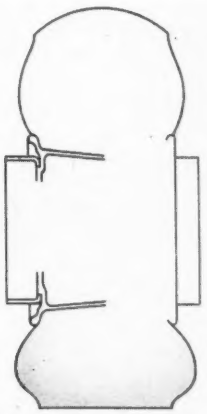
MAKERS OF B. F. GOODRICH TIRES AND OVER 80 RUBBER AND SYNTHETIC RUBBER PRODUCTS FOR AIRPLANES

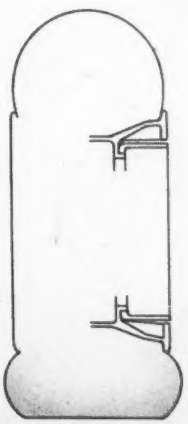
ARMY E NAVY

Why Smooth Contour Silvertowns mean

SAFER LANDINGS AT HIGH SPEED!

The advantages of Low Pressure and Smooth Contour Silvertowns are shown in these sketches. The Low Pressure Silvertown (a), with smaller bead diameter, has adequate braking surface for transport and slower-speed ships, *plus* extra cushioning vital in many operations. The Smooth Contour Silvertown (b), with much larger bead diameter, provides room for the extra braking surface needed to stop a fast warplane quickly. It offers the advantages of both high pressure and low pressure tires, modified to meet military requirements of speed.





Note the wide footprint and non-skid, self-cleaning tread—both features of B. F. Goodrich Smooth Contour Silvertowns which assure maximum ground contact and stability.

This test tells the tale. The heavy road wheel on this machine is rotated to simulate landing speeds up to 150 m.p.h. When the desired speed is reached, tire is thrust against road wheel and braking applied until it comes to a full stop. By timing this operation, the exact rolling distance can be found.

In war or peace

B.F.Goodrich

FIRST IN RUBBER

De-Icer Slide Film for Designers—Now Available!

ALL DESIGNERS OR MANUFACTURERS OF AIRCRAFT SHOULD SEE THIS IMPORTANT STEP-BY-STEP STORY OF DESIGN FOR DE-ICER PROTECTION. This reading slide film sets forth the "know-how" of providing the best De-Icer protection for your new airplanes in a clear, detailed manner that technical men will appreciate. Some of the topics covered are design procedures, types, methods of installation, basic air supply system, attachments, and aerodynamics of the De-Icer.

A reproduction of the film is presented in an attractive, pocket size booklet, and copies are available to designers and engineers on request.

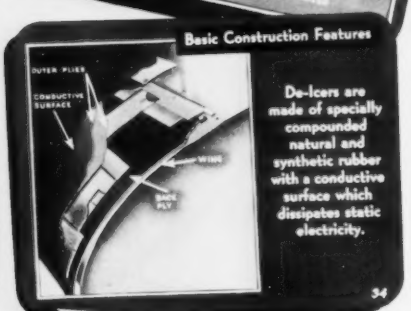
The pictures on this page will give you a hint at the data you may expect to find in the film. If you have any part in the planning of airplane design, be sure to send us your order, as explained in the ordering instructions below.

Other films in the series, announced earlier, are "The Development of the De-Icer," and "De-Icer Servicing and Installation."

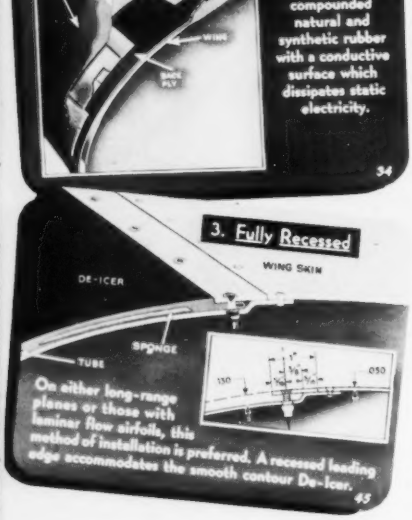
De-Icer Attachment
Let us examine the De-Icer attachment more closely. Here are the main elements —
Rivnuts — act as nut plates to hold the
Screws — that fasten the De-Icer bead and
Fairing Strips — that clamp the beads and fair the contour smoothly into the wing.
FAIRING STRIP
DE-ICER
WING
RIVNUT
ASSEMBLED

A general description of the various units as they are used in a typical system will be given next. Detailed information on all De-Icer accessories is available from Eclipse Aviation.
83

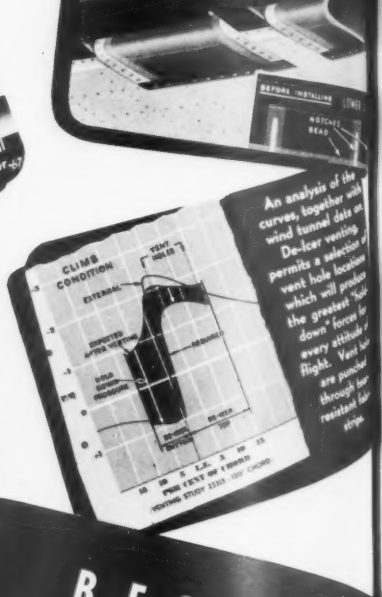
In protecting wings with fixed slots, the lip of the wing to the slot should be protected. Movable portions of the De-Icer. The De-Icer can be notched to permit concealed installation the attachment with standard Fairing.
BEFORE INSTALLING
NOTCHES READY


Basic Construction Features
OUTER PLIES
CONDUCTIVE SURFACE
De-Icers are made of specially compounded natural and synthetic rubber with a conductive surface which dissipates static electricity.
34

De-Icers for large duct openings may have special beads to permit smooth attachment within the duct, using regular Fairing Strip. Rubberized patches seal corner notches to prevent the entry of air and water.
67


3. Fully Recessed
DE-ICER
WING SKIN
SPONGE
TUBE
On either long-range planes or those with laminar flow airfoils, this method of installation is preferred. A recessed leading edge accommodates the smooth contour De-Icer.
45

STEEP CLIMB CONDITION
DIVE CONDITION
LIFTING PRESSURE
DEFLECTING PRESSURE
Vent locations can be selected by stress analysis. Required pressures between the rubber and wing for each attitude of flight are computed on the basis of local De-Icer tension and wing curvature. These values are plotted with the pressure distribution curves for the specific airfoil and flight attitude.
98


CLIMB CONDITION
VENT HOLES
EXTERNAL
An analysis of the curves, together with wind tunnel data on De-Icer venting permits a selection of vent hole locations which will produce the greatest "hold down" forces for every attitude of flight. Vent holes are smaller through heat resistant fabric strips.

HOW TO ORDER—All the De-Icer slide films and booklets are available without cost when requested on your business letterhead. Address your inquiry to the B. F. Goodrich Co., Dept. 7191, Akron, Ohio. The booklets will be furnished in sufficient quantity for all members of your organization who might be interested. "De-Icers & Design" will be especially helpful to airplane manufacturers, designers and engineers, while "Development of the De-Icer" and "De-Icer Servicing and Installation" will be of interest to everyone concerned with De-Icer operation, maintenance and servicing.

B. F. Goodrich
Aeronautical Division
Akron, Ohio

important forgings were the engine mounts, dive brakes, and super charger impeller."

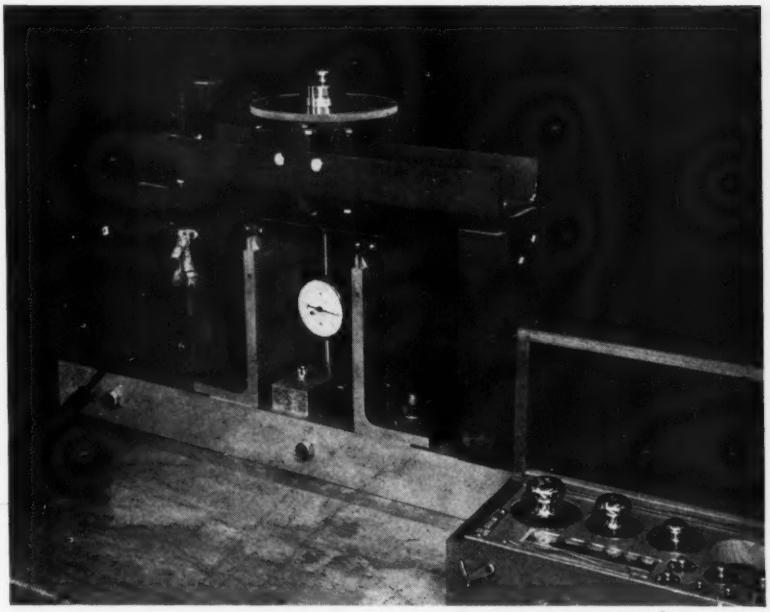
Aluminum-Alloy Temperature Aging

Aging of strong aluminum alloys at elevated temperatures is by no means new, and the attainable physical properties have been frequently studied. Paul P. Mozley, of Lockheed Aircraft Corporation, in his paper on *Elevated Temperature Aging of 24S Aluminum Alloy*, pointed out quite rightly that the fear of corrosion difficulties and the lack of detailed information regarding physical properties obtainable and the optimum time and temperature required to attain these desired properties have delayed application of the process in aircraft fabrication. This lack of data prompted the author to undertake an extensive investigation under the auspices of the Lockheed Aircraft Corporation. The conclusions were highly encouraging.

"The tensile yield strength, ultimate tensile strength, and compressive yield strength of 24S aluminum-coated sheet may be increased by aging at elevated temperatures without appreciably lowering the corrosion resistance of the material. These values are further increased by a slight amount of plastic deformation before the aging treatment. The increase in properties depends upon the degree of plastic deformation, the aging temperature, and the time at the aging temperature. The optimum properties may be obtained on material that has been stretched to a permanent set of 1 per cent in approximately 16 hours at 350°F. and in approximately 7 hours at 375°F. No effects of elevated temperature aging other than the decrease in elongation should cause any apprehension in the use of elevated temperature aging in the fabrication of aircraft parts . . . . " from aluminum-coated 24S alloy in gauges of 0.032 or heavier or the bare 24S alloy of relatively heavy sections.

Austenitic Stainless Steels

While a great deal has been written on the corrosion- and heat-resistant properties of austenitic stainless steel, relatively little has been said regarding their mechanical properties. R. A. Lincoln and W. H. Mather, of Allegheny-Ludlum Steel Corporation, in their paper on *Mechanical Properties of Austenitic Stainless Steels*, indicate that slight changes in composition may affect mechanical properties to a high degree because such changes affect the stability of austenite with respect to its tendency to transform into ferrite at room temperature. The paper dealt exhaustively with the various compositions and related them to yield strength, tensile strength, elongation, and compression. Some of the tests were made on material taken from the actual machine being constructed in stainless steel in the Stout Engineering Laboratories. The paper is far too technical and detailed for adequate review. There is no doubt, however, that by carefully controlling the relative amounts of chromium, nickel, manganese and carbon present in austenitic stainless steel it is possible to obtain alloys that can be rolled to extremely high tensile strengths and still have good ductility. For one alloy in particular, a tensile strength of 200,000 lbs. per sq.in. may be combined with yield strength of 170,000 lbs. per sq.in. and elongation of 15 per cent. High strength values have been attained for some of the alloys still with remarkable elongation properties. At one time, great hopes were founded on stainless steel. The fashion then swung the other way because of difficulties in fabrication and because it was thought that high strengths were combined with lack of ductility. This paper should serve to extend interest and confidence in these materials.



Apparatus for determining the *EI* of design-strengthened flat strips by the simple beam test. (From *Design-Strengthened Sheet Metal.*)

Torsional Damping

In the study of aircraft flutter and vibration one of the gaps in our knowledge has been with regard to the damping properties of material subject to dynamic stresses. Wherever materials are used it is absolutely indispensable to know fatigue strength and fatigue limits and it is also necessary to know what the damping capacities of the material are. Sufficient argument in favor of knowledge of characteristics lies in the fact that the resonance amplification factor is proportional to the reciprocal of the damping capacity of the material which, in turn, is a measure of the energy absorbed by internal friction during one stress cycle. A. U. Kutsay and A. J. Yorgiadis, of The Pennsylvania State College, have made a study *On the Torsional Damping Capacity of Solid Magnesium Alloy Rods as Affected by Cold-Working.* Some interesting test techniques were developed and discussed, in particular, methods form easuring damping capacity. While methods for measuring damping capacities have long been known, here there is a definite technique both in inducing vibrations and in the measurements of deflection oscillations and the like. Appropriate formulas are also available for the evaluation of tests. Quite definite conclusions were reached which apply at least to the magnesium alloys tested. The most important of these conclusions were as follows:

"(1) Damping capacity increases and dynamic modulus of rigidity decreases with increasing stress.

"(2) Damping capacity decreases and dynamic modulus of rigidity increases with cold-working.

"(3) The higher the cold-working stress, the lower is the damping capacity, and the higher is the modulus of rigidity for any given stress.

"(4) At stresses lower than the cold-working stress, the decrease in the

DIRECTIONS are vital to pilots. That's easy to understand. But what is not so widely known is this: Aircraft compasses must be regularly adjusted to fight off the magnetic influence of other equipment in the ship . . . must also be corrected for the magnetic variations found at different spots on the earth. To make these corrections, the pilot must be able to refer to *true directions* while his ship is on the ground.

The Compass Swinging Sight makes this possible, whether the airfield be buried among Alaskan mountains or deep in a tropical jungle. This device, used principally in the operation of emergency fields, establishes to hair-line accuracy the points of the compass. It thus makes it possible to correct the instruments on which the safety and success of every flight depends.

Like the other electrical and navigational instruments we are making, the Compass Swinging Sight has a single mission . . . to remove the hazards of guess-work and thus to insure the efficiency and effectiveness of our aerial combat forces.

"Which way's Rangoon from here?"

The W.W. **BOES** *Company, Dayton, Ohio*

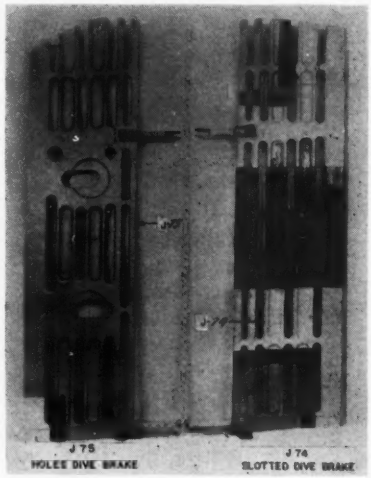
MANUFACTURERS OF ELECTRICAL AND NAVIGATIONAL INSTRUMENTS FOR AIRCRAFT

TO THE INDUSTRY! The American aviation industry is performing miracles in war production, but our duty doesn't stop there. We must also lead in the purchase of the war bonds that help to pay for the products we produce. Keep on buying war bonds—MORE IF POSSIBLE!

damping capacity and the increase in the modulus of rigidity are more pronounced than at stresses higher than the cold-working stress."

Radio-Frequency Case Hardening

Applications of radio-frequency energy in dealing with materials is becoming increasingly important. For example, in gluing up plywood, short-wave radio application of heat is proving highly satisfactory. V. W. Sherman, of the Federal Telephone and Radio Corporation, has made an excellent investigation of *Thin Case Hardening with Radio-Frequency Energy*. Compared with other processes of case hardening, there is this advantage for radio-frequency methods—that they make possible distortionless thin case hardening and this makes possible finishing of parts to final dimensions prior to heat-treatment. In the field of heat-treating it has long been desirable to create a hard skin over a tough interior, but there has been conflict between the two requirements. Surface heat-treatment has had two practical faults: Heat has penetrated too deeply and penetration has been frequently far from uniform. In the process described by the author the principle is that an iron cylinder if placed within the turns of the induction heating coil energized with alternating current receives heat. The high rate of energy input over a short time interval restricts heating to controllable surface layer. Provided this rule is observed and if operating frequency is enormously high of the order of high-frequency radio, valuable results can be obtained. With the restriction of heat to the surface layer of the work, increased speed of lower case energy results. If case hardening is high speed, there is freedom from distortion or warpage. Freedom from scaling makes final machining prior to heat-treatment feasible. Since the heat gradient between surface and interior is high, self-quenching of the surface is usually possible. Space requirement of the vacuum-tube oscillator is small. Its power supply can be located at a remote point and its work load can be located either at the oscillator or coupled to it from a distance by means of a grounded concentric line. There is no loss in hardness of the adjacent interior layer provided the process is quickly carried out. Aircraft metallurgists and others concerned with aircraft materials will undoubtedly study the paper with considerable interest.



Junkers J74 and J75 forged dive brakes. (From *Use of Magnesium in German Aircraft.*)

Meteorology

Thunderstorms

It is extraordinary how profoundly scientific the meteorologists of our air lines are. Thus we find C. E. Buell, of American Airlines, Inc., writing a highly mathematical paper on the *Determination of Vertical Velocities in Thunderstorms*. A formula is derived connecting maximum vertical velocity, the gas constant, surface temperature, surface pressure, and the height of the jump on the barograph trace. Three causes are taken into account in the development of thunderheads: (a) the fully developed cumulo-nimbus, (b) the well-developed cumulus congestus and (c) the developing cumulus or cumulus congestus.

The calculations are followed by tables. The results of the calculations were found to be in close agreement with the current experiences of air-line pilots who, not infrequently, report vertical velocities from 2,000 to 3,000 ft. per min.

Lightning

Lightning Phenomena was the title of a paper by G. D. McCann, of Westinghouse Electric & Manufacturing Company. Lightning phenomena have been studied for a long time and from many points of view, yet the subject is so complex that there remains much to be learned. For the last five years the Westinghouse Electric & Manufacturing Company has been conducting a program of field research coordinated with laboratory and theoretic studies. While this has been principally from the point of view of developing better methods of electrical power system production, the data obtained have contributed to the general knowledge of lightning phenomena. The paper described particularly the photographic study that has been made of the visual mechanism of lightning strokes. The discharge currents have been measured at 25 stations on structures ranging in height from 65 to 585 ft. These data have been correlated with other investigations giving information on the distribution of charge in thunder clouds, the types of discharges that can occur, and their frequency and the discharge mechanism. The fundamental characteristics of charge generation and discharge mechanism are the same in whatever country they have been studied. The distribution of cloud charge consists of positive charge in the upper cloud regions and negative, with one or more small positive centers, in the lower regions of the cloud. The great preponderance of strokes to ground involve only the negative charge, and those within the cloud are mostly between the negative charge in the cloud base and the positive charge in its top.

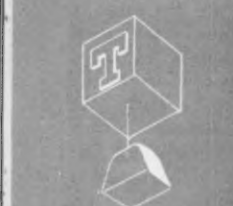
A number of unusual stroke conditions were presented and the effect of the height of the object on the number of times it is struck per year was discussed. There is a remarkable increase with height; 500 ft. indicated two strokes per year and 1,200 ft. gave 20 strokes per year. Statistical data were given on the variation of the multiple character and duration of strokes to ground and cloud to cloud discharges. Data of the same kind were given for the magnitude and wave shape of the discharge currents, together with information on the fusion of metal due to arc contact and in conductors carrying the stroke current.

Cloudiness

James M. Austin, of the Massachusetts Institute of Technology, went into the question of *Cloudiness and Precipitation in Relation to Convergence*. The aim of this investigation was a quantitative study of the production of cloudiness and precipitation as the result of convergence in the horizontal airflow. By obtaining the divergence of the gradient wind it has been possible to determine some of the factors that contribute to horizontal convergence, which has been evaluated by means of the equation of continuity. Finally, the likelihood of precipitation was determined by considering the moisture content and the convective state of the moving air mass.

IMPACT STRENGTH

FLEXURAL STRENGTH



TENSILE STRENGTH

DIMENSIONAL STABILITY

HARDNESS

ABRASION RESISTANCE

PHYSICAL PROPERTIES OF "BAKELITE" PLASTICS

that mean Fighting Strength

THE SEVERE SERVICE under which equipment must operate today puts heavy demands on plastic materials. In many instances, plastic parts must possess not only high tensile strength, but impact resistance and hardness as well. Other parts may require high flexural strength combined with dimensional stability and wear and abrasion resistance. Thus the designer and engineer, in selecting plastics, must constantly keep in mind the correct balance of *all* these physical properties.

The problem may be the selection of a BAKELITE Plastic material possessing high impact resistance, with tensile or flexural strength requirements running a very close second. On the basis of impact resistance alone, it might seem advisable to choose a high-impact BAKELITE Phenolic Molding Material. But such a material might not meet tensile strength requirements! On the other hand, a general-purpose BAKELITE Phenolic that possesses the required tensile strength can have as little as 1/18 the shock resistance of the high-impact material! In such a case, final choice of material may lie between the two extremes.

The design of the part has a lot to do with its ultimate strength characteristics. Frequently, BAKELITE Molding Boards and Blanks are used in conjunction with general-purpose phenolic plastics to provide reinforcement around inserts, and at corners, shoulders, and other points that are subjected to severe service. Mechanical strength may also be improved by increasing wall thickness or by making adjustments in fabricating techniques.

Apart from these physical properties, mechanical strength can also be interpreted in terms of *toughness*, particularly with flexible plastics that are not usually tested for impact resistance. *Mechanical fatigue* may also become a major problem where plastics are placed under load, or are subjected to repeated blows, or to continued flexing.

On the facing page are presented the outstanding physical properties of those BAKELITE Plastics of primary importance to war production. Later messages will deal with the chemical, electrical and thermal properties. For more detailed information write for a copy of Booklet 25—"A Simplified Guide to BAKELITE Plastics."

BAKELITE CORPORATION, 30 E. 42nd St., New York
Unit of Union Carbide and Carbon Corporation

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PLASTICS HEADQUARTERS

Physical Properties of "Bakelite" MOLDING MATERIALS

Thermosetting General-Purpose Phenolics

These materials provide well-balanced combinations of dimensional stability and other physical properties suitable for everyday requirements. *Impact strength:* 0.26 to 0.40 foot-pounds per inch of notch (Izod). *Tensile strength:* 6,500 to 8,500 pounds per square inch. *Flexural strength:* 8,800 to 13,000 pounds per square inch.

Thermosetting Shock-Resistant Phenolics

Four types, offering a wide range of physical properties. All types are dimensionally stable, and resistant to wear and abrasion. Depending upon type, *impact strength:* from 0.46 to 5.4 foot-pounds per inch of notch (Izod); *tensile strength:* from 5,300 to 8,500 pounds per square inch; *flexural strength:* from 6,300 to 11,000 pounds per square inch.

Thermosetting Phenolic Molding Boards and Blanks

These are medium-high, impact materials that may be used in molds built for general-purpose phenolics. Can be used alone, or with other plastics to provide reinforcement at vital points. Supplied as board stock or as blanks approximating shape of finished part. Also sold in diced form suitable for automatic preforming. Depending upon type, *impact strength:* from 1.6 to 2.0 (with grain) and 0.6 to 0.9 (against grain) foot-pounds per inch of notch (Izod); *tensile strength:* from 3,000 to 11,000 pounds per square inch; *flexural strength:* from 8,400 to 25,000 pounds per square inch.

Special Phenolics

This group comprises a variety of dimensionally stable, thermosetting materials, for special requirements of heat resistance, low power factor, chemical and water resistance, low friction coefficient, opacity to X-rays, and transparency.

Thermosetting Ureas

Most color stable and hardest of all thermosetting plastics. *Impact strength:* from 0.30 to 0.36 foot-pounds per inch of notch (Izod); *tensile strength:* from 9,500 to 12,000 pounds per square inch; *flexural strength:* from 10,000 to 14,000 pounds per square inch.

Thermoplastic Cellulose Acetates

Two types—Class I, general purpose, for compression and injection molding, and Class II, heat- and water-resistant, for injection molding only. Both types noted for high impact strength, toughness, and wide color range. *Impact strength:* from 1.4 to 4.0 foot-pounds per inch of notch (Izod); *tensile strength:* from 2,500 to 9,500 pounds per square inch; *flexural strength:* from 5,000 to 15,000 pounds per square inch.

Thermoplastic Polystyrenes

Outstanding in dimensional stability, chemical resistance, and dielectric qualities. For compression as well as injection molding. Supplied as crystal-clear material, and in transparent and translucent colors. *Impact strength:* from 0.40 to 0.70 (compression-molded), 0.8 to 1.2 (injection-molded) foot-pounds per inch of notch (Izod); *tensile strength:* 5,500 to 6,500 (compression), 6,500 to 7,000 (injection) pounds per square inch; *flexural strength:* 6,500 to 7,500 (compression), 14,000 to 19,000 (injection) pounds per square inch.

Physical Properties of Laminated Plastics made with "Bakelite" LAMINATING VARNISHES

BAKELITE Laminating Varnishes are used in the production of paper-base and fabric-base laminated sheets, tubes, and rods. Laminated plastics made from these varnishes possess excellent dimensional stability, high impact, tensile, and flexural strength, and are extremely resistant to wear and abrasion. In addition, they offer an unusual combination of other properties such as high dielectric strength, resistance to corrosion, and immunity to water, brine, oil, ordinary solvents, most acids, and weak alkalies.

Physical Values

Tensile strength of standard paper-base grades ranges from 7,000 to 12,500 pounds per square inch; flexural strength (transverse), from 15,000 to 21,000 pounds per square inch; and compressive strength, from 22,000 to 36,000 pounds per square inch. For standard fabric-base grades, tensile strength ranges from 8,000 to 10,000 pounds per square inch; flexural strength (transverse), from 17,000 to 20,000 pounds per square inch; and compressive strength, from 35,000 to 38,000 pounds per square inch.

Sheets, Rods, Tubes, Special Shapes

Laminated sheet stock and gear stock is supplied by laminators and fabricators in various thicknesses and sizes. Tubing can be obtained in lengths from 36 inches, with I.D. from 3/16 of an inch to 72 inches. Larger tubing can be made for special requirements. Rods come in standard lengths up to 48 inches, and in diameters from 1/8 of an inch to 4 inches. Special shapes are made to order.

Special Types

In addition, special laminated plastics have been developed for specific mechanical requirements. Molded-laminated plastics permit the manufacture of such unusually tough and wear-resistant products as heavy-duty bearings. Rubber-laminated plastics combine the rigidity and mechanical strength of laminated plastics with the vibration-absorbing qualities of the rubber interlayer. Tough, densified-laminated woods also are made possible by impregnating wood veneers with a laminating varnish and subsequently applying heat and pressure.

Physical Properties of "Bakelite" BONDING MATERIALS

Phenolic and Urea Resin Wood Glues

For bonding plywood and other wood products. Glue line is dimensionally stable under extreme conditions of heat, cold, moisture, and impact shocks. Bonded woods are resistant to mould growth.

Resin Cements for Lamp Basing

Because of their dimensional stability when subjected to heat, BAKELITE Resin Cements are used widely to set electric light bulbs and radio tubes in their metal or plastic bases. Mechanical shock or vibration does not impair the bond.

Resin Cements for Bristle Setting

A tough, tenacious bond for bristles used in brushes of all types is provided with BAKELITE Resin Cements. The bond obtained is unaffected by constant use, or by frequent cleaning in water or solvents.

Bonding Resins for Glass and Mineral Wool

To form glass, rock, and mineral wool into easily handled, dimensionally stable insulation batts, the fibers are bonded together with BAKELITE Resins. Heat cold, and moisture do not affect bonding strength.

Bonding Resins for Abrasive Products

Abrasive grit used to form high-speed grinding and cut-off wheels is securely bonded with BAKELITE Resins. This tough, strong bond has made it possible to operate grinding wheels safely, at speeds considerably higher than with other bonds.

Resins for Brake Linings

Both woven and molded brake linings are processed with BAKELITE Resin for greater toughness, dimensional stability, and resistance to wear and heat.

Physical Properties of SURFACE COATINGS *made with "Bakelite" Resins*

BAKELITE Synthetic Resins, when formulated into protective coatings, provide such properties as durability, faster drying speed, toughness, hardness or flexibility, resistance to wear and abrasion, and resistance to water and chemicals.

Phenolic Resins

For fortifying paints, primers, varnishes, and enamels of all types. Outstanding are the para-phenyl-phenol type of resins BR-17000 and BR-254, which have established new standards of durability for government and industrial specification coatings. Numerous other BAKELITE Phenolic Resins are serving widely diversified coating requirements. Certain types are used to fortify non-phenolic coatings to improve performance.

Dispersion Resins

These resins provide coatings with an unusual combination of properties—extremely fast drying time and maximum resistance to moisture. Such coatings dry as fast as *one minute*, entirely by solvent evaporation, without need of baking treatment. Because they are non-oxidizing, they do not become brittle after long years of service. They are especially useful as primers for ferrous and non-ferrous metals, particularly aluminum and magnesium alloys.

Baking Resins

For hard, abrasion-resistant coatings for lining cans, drums, and tanks. Baked on immediately after application, they provide high resistance to heat, chemicals, and moisture. Equipment need not be dismantled nor shipped out of the plant; the coatings can be applied, *right on the job*, by means of special, portable baking apparatus.

C-9 Resins

For coatings on cloth, paper, concrete, plaster, brick, plastics, wood, and metal, these versatile resins contribute many unusual physical properties. They are noted for their adhesion and long retention of flexibility. In wet scrub tests, water-emulsion paints made with them far exceed durability required in government specifications. Baking enamels based on them do not blister or flake even when immediately plunged into cold water after long baking.

Physical Properties of "Bakelite" IMPREGNATING, SEALING, and CALENDERING MATERIALS

Calendering Resins for Cloth

Cloth calendered with BAKELITE Resins gains added toughness with little or no sacrifice in flexibility. The resins impart a high order of resistance to water, chemicals, and heat.

Resins for Wood Densifying and Stabilizing

The many important advantages of wood are supplemented by high mechanical strength and excellent resistance properties when impregnated with BAKELITE Resins. In particular, the moisture content of wood veneers can be stabilized by such treatment. Impregnated veneers can be compressed into densified wood, known as "compreg," with specific gravity up to 1.37. On parallel-grained specimens, modulus of rupture can reach 38,000 pounds per square inch (with grain), and compressive strength 25,000 pounds per square inch (with grain). "Compreg" is fire retardant, has excellent aging properties, and is resistant to sulphuric and hydrochloric acid solutions.

Sealing Solutions for Castings

Castings ordinarily rejected for porosity and small blowholes are reclaimed by forcing BAKELITE Sealing Solutions into the pores under pressure, and then baking. The sealing solution thus becomes exceedingly hard and tough, unaffected by hot or cold water, steam, oils, chemicals, or heat up to 400 deg. F.

Impregnating Varnishes for Windings

As protective coatings and insulating bonds for coils, armatures, and windings, BAKELITE Varnishes remain stable and hard despite elevated operating temperatures and high rotational speeds. Better mechanical strength is also obtained.

Tunisian Take-off

A "Marauder" gets away on AEROLS*

Far superior to similar Axis planes, Martin's B-26 bomber, called the "Marauder," has established an enviable record in the North Africa campaign.

Equipped with Aerols, the "Marauder" takes off and lands readily on the unfavorable terrain of Tunisia.

In today's global war, Aerols are also serving on every other front, on every type of plane. From the steppes of Russia to emergency fields in the South Sea Islands, Aerols are contributing to the achievements of American aircraft.

THE CLEVELAND PNEUMATIC TOOL COMPANY
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Also Manufacturers of Cleco pneumatic tools for the aircraft and general industry, Cleco sheetholders, Cle-Air shock absorbers for trucks and buses, and Cleveland rock drills for mining and construction work.

*THE SHOCK ABSORBING UNITS ON AN AIRPLANE'S LANDING GEAR; THE NAME IS DERIVED FROM THE WORDS "AIR" AND "OIL"—THE FLUIDS USED TO DISSIPATE THE LANDING SHOCKS

Instrument Improvements

Laurence W. Foskett and Norman B. Foster, of the Instrument Division, U.S. Weather Bureau, in their paper *A Spectroscopic Hygrometer*, made some interesting tests of a simple grating spectrophotometer used in conjunction with a tungsten filament lamp to measure directly the precipitable water in the atmosphere. Utilization was made of the 1.380 μ water vapor absorption band. Vacuum thermocouples and high sensitivity galvanometer are employed for energy measure. Included was a discussion on the calibration and field tests made at the Laboratory of the Institute of the Aeronautical Sciences, Sands Point, L.I. Calibration tests were conducted over optical paths of from 1.5 to 52 m.; precipitable water paths were from 0.0023 to 0.083 cm.

The investigators found, as a result of their field tests, that the values obtained from the psychrometer are more irregular and have a greater spread than those from the spectrophotometer and, under most conditions, more representative indication of atmospheric moisture is given by the optical method. Nevertheless, the authors suggested a number of improvements in the spectroscopic hydrometer which included (1) replacing the high sensitivity galvanometer with more rugged measuring equipment, (2) providing a better optical system for the projection equipment, (3) obtaining the photometric rations from single observations, and (4) improving the control of conditions under which calibrations are to be made.

Physiologic Problems

Apart from the meeting itself on physiologic problems, a distinguished naval captain and medical officer created a sensation in the airplane design session by producing a blackjack and brass knuckles. Generations of gangsters have taken care to produce weapons that can render a man unconscious without killing him. They have done this by carefully covering metal with rubber and by rounding off brass knuckles. The lesson for aircraft designers is that all parts of the airplane likely to strike occupants should be suitably covered with rubber or other protective material and that sharp edges should invariably be avoided. A compass placed at the level of a pilot's forehead could be the cause of fatal injury in a comparatively minor crash. Almost all the papers in the physiologic problems session were concerned with lessons that airplane designers might well accept at the hands of the flight surgeon.

Vision and Hearing

Thus L. D. Carson, Medical Research Section, Bureau of Aeronautics, U.S. Navy; Walter Miles, Yale University Medical School; and S. S. Stevens, Harvard University, discussed *Vision, Hearing, and Aeronautical Design.* Since vision is vital to correct landing, blanking off of vision from the area ahead of the pilot may be a particularly vicious drawback. Aircraft carrier accidents have undoubtedly resulted from the blanking off of vision area by large air-cooled engines. The authors suggest that mirror reflections of the area immediately ahead of the plane could be provided. Another suggestion is that the pilot should be placed as near as possible to the transparent panels, because the nearer the eye is to the window, the larger the field that can be seen from it and the smaller the window needed. The transparent area should be free from obstructing pillars, panels, joints, and opaque accessories. The gunner's visual problem is particularly important and we cannot resist quoting some remarks:

"The position of gunners in relation to windows is especially worthy of consideration. Take a hypothetic set of measurements for discussion. The gunner's eye must be about 9 in. behind the gunsight; the sight is 20 in. from the aiming panel; the gunner's seat is therefore placed against the back wall of the turret, and the space in front of him is well filled with gun supporting and operating structures. The aiming panel is a beautifully clear, optically perfect surface 14 by 14 in. The engineers are to be congratulated on this window but not on the position of the gunner. For him the situation resembles that met in tunnel vision. His eyes are 29 in. away from this superb window which can provide him with a view of only 28°—that is, 28° of the full 60° to 90° that are so critically needed."

In turrets where guns may be mounted at the side and rather low down it should be possible to reduce the amount of structure in front of the gunner and to bring him forward much nearer the front panel. Faults in instrument panel design include the following: (1) There is too much illuminated area; (2) reflected light from the instruments is usually not of the band least disturbing to night vision; and (3) the intensity is far too high. With regard to cockpit enclosures the medical officers find them subject to discoloration under sunlight. Vision is generally poor above and aft.

Hearing suffers more than sight. In the view of the medical officers the noise is far too high. Severe criticism lies in the fact that communications are masked by noise. A definite recommendation is that the microphones and earphones should be shielded from noise, possibly by way of the oxygen mask.

Medical Research

The medical supervisors, William E. Russell and John R. Erwin, of Boeing Aircraft Company, cooperated with Hugh DeHaven of Cornell University Medical College, in a paper entitled *Medical Research in Some Aspects of Aircraft Design.* It was the definite feeling of the authors that pressurized suits, pressurized cabins, or some type of pressure oxygen mask offers the necessary protection for high operational flights. Pressurized suits are large and bulky and the suit is apt to loose its pressure if the pilot is moving around in it. There is also a definite limit on the pressure that can be built up in a suit.

The authors discussed the possibility of quick loss of pressure in pressurized cabins or excessive decompression, as it is called. The safeguard here would be to use pressure masks that would supplant pressurized cabins in case of some accident releasing the pressure. An ever enlarging group of crashes is one that is not extreme and in which a substantial portion of the cockpit or cabin remains intact. This type of crash can be termed marginal. Survival in such a minor crash is a matter of chance, depending upon how the body is thrown. Here there seems to be a great field for improvement and research in appropriate restraint of the bodies of the occupants and, particularly, in a structure that will provide protection against head crashes. Rudder pedals that would support the foot would cancel out many foot and leg injuries.

Human Heat

Louis H. Newburgh, University of Michigan; L. P. Herrington, John B. Pierce Laboratory of Hygiene; A. P. Gagge, U.S. Army Aero Medical Research Laboratory, Wright Field, discussed *Limits of Human Heat Regulation.* The paper indicated that the aviator does not produce sufficient heat to protect himself against prolonged cold and that there must be heat application to the plane or to the clothing by electrical resistance or an increase in the insulated value of clothing.

Dual Rotation – *the dawn of a new air age!*

TOMORROW'S SUPER-SHIPS are in the making now. Ready for them is the Aeroprop Dual Rotation Propeller. Developed through seven years of intensive engineering, the Dual Rotation Aeroprop is now ready for mass production—for our fighting ships and for the new air age of tomorrow.

Two sets of Aeroproducts' hollow steel blades, rotating in opposite directions, harness the vastly increased horsepowers of new aircraft engines. Thus, the Dual Rotation Aeroprop meets the demand for a propeller which absorbs greater horsepowers... improves propeller efficiency... reduces propeller sizes... and streamlines air-flow for greater speed, stability and safety.

In the swift rise of America's air supremacy, more powerful engines and improved propellers are an all-important team. This Dual Rotation propeller furnishes evidence that this progress will continue—that Aeroprops for tomorrow's planes will be ready.

AEROPRODUCTS *DIVISION*
GENERAL MOTORS
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GM ARMS FOR VICTORY

BUY WAR BONDS — KEEP AMERICA FREE!

In practice, heated clothing may be objectionable because of drains upon available current and because pilots are afraid of burns. Development of a fabric whose capacity to retard heat flow should be twice that of the textiles now in use was urged. Problems of cooling in the tropics were also discussed in this paper, and physiologic reasons were given for the use of salt to replace sodium chloride lost from the body sweating.

Naval Aviation

Medical Activities in Naval Aviation by James C. Adams, Bertram Groesbeck, Jr., and Eugene F. DuBois, U.S. Navy Bureau of Medicine and Surgery, dealt with the Navy's method of pilot selection and the problems of altitude, night vision, and pilot fatigue. There seems to be great need for cooperation between the doctor, the airplane engineer, and the industry in general.

Power Plants and Propellers

Blade Stress Analysis

One of the difficulties in stress analysis of propellers has been the fact that a complex and unsolvable differential equation is involved. When the propeller yields under thrust, effects of the centrifugal moment change. When the differential line of the propeller changes under centrifugal moment, conclusions have to be again revised. No completely exact mathematical method has been available hitherto. Joseph Stuart III, Aeroproducts Division, General Motors Corporation, in his paper on *A Tabular Method of Propeller Blade Stress Analysis*, offers a trial-and-error method that seems to answer practical needs. The bending moment at a shank section of the blade is estimated, and by tabular integration the corresponding radial bending moment distribution is calculated. Additional trials with appropriately revised shank section bending moment estimates are made until the distribution is found having the physically required moment value of zero at the blade tip.

Tilted blades and blades whose section centers of gravity do not, in general, fall on the blade axis are shown to be readily analyzed. Because the final analysis can be quickly checked on a calculating machine and because the method is easily learned, versatile, and fast, its general adoption by the propeller industry is advocated.

Propeller Balancing

There is not the slightest doubt that propeller balancing is an essential element of passenger and crew comfort on the air lines. Lack of propeller balance may cause most serious engine and propeller effects which will be forced into the structure of the airplane and into the cabin. Jere T. Farrah, of American Airlines, Inc., in his paper on *Problems of Routine Propeller Balancing*, points out that propeller balancing is a strange problem. Small things affect balance. For example, if a propeller is removed from the engine and replaced on the same spline with the same position of the rear cone, balance may be changed. Many different types of equipment have been tried in practical work. For the most part, propellers are nearly always balanced upon the airplane upon which they are to be used. However, research is now under way to develop a method of balancing engine-propeller combinations on the test stand. While much remains to be done in propeller balancing, the possibilities of test stand work are beginning to be understood. Fundamentally, the problem is that of developing a means of measuring an unbalanced couple quickly and accurately. In particular, it was thought that the balancing problem was up to the propeller manufacturers—namely, means for correcting unbalances that occur when the propeller is put into use. These devices should be such that a couple could be added, weights being added to two balances. Whatever the method, it should be simple and easy to use when applied to routine servicing. Balancing equipment itself might well be made more compact, easier to set up, and, above all, of so simple a character that it could be handled by service mechanics.

Engine Efficiency

Profs. John Markell, Jr., and C. Fayette Taylor, of the Massachusetts Institute of Technology, presented a study of *The Volumetric Efficiency of an Internal Combustion Engine* using a Ford V-8 provided with full dynamometer and other equipment. They obtained the volumetric efficiency and variations in revolutions per minute in inlet pressure, exhaust pressure, inlet temperature, and jacket temperature over a wide range. Operating conditions have an effect on volumetric efficiency and the subject is far from being exhausted. The results of the test presented in a series of charts can be studied with considerable interest.

Exhaust Valve Design

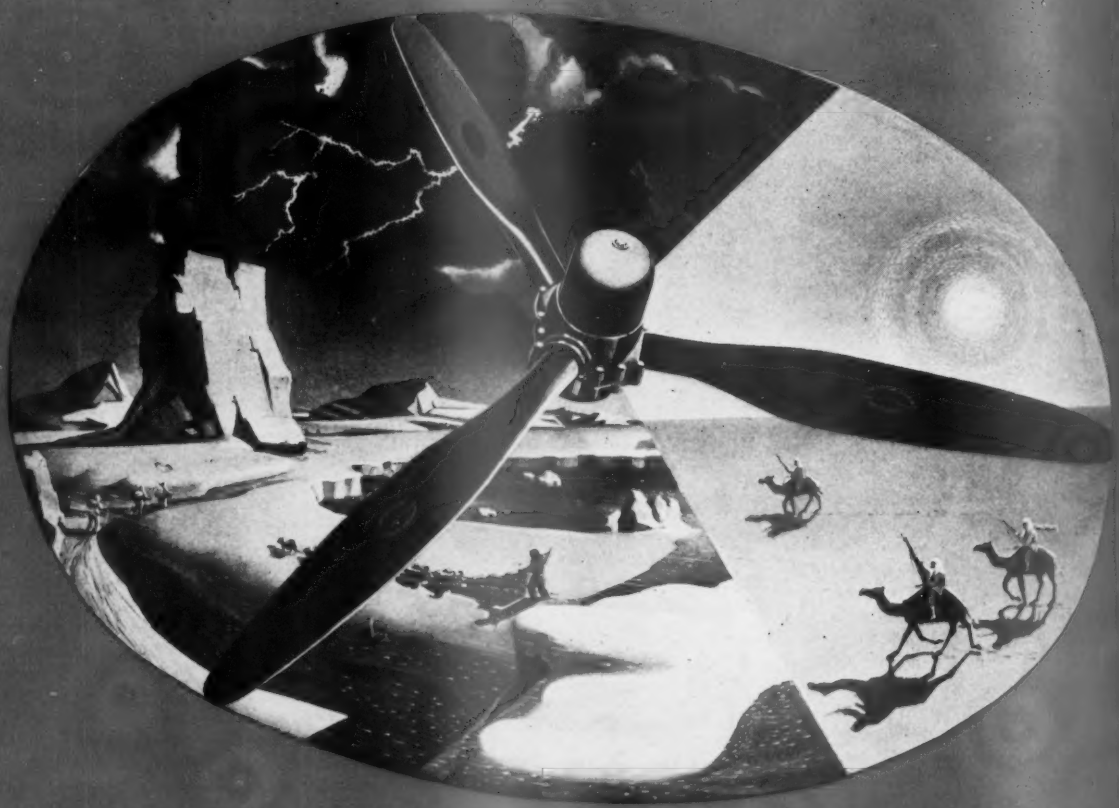
Seng-chiu Hu, also of the Massachusetts Institute of Technology, was interested in a *Study of Exhaust Valve Design from Gas Flow Standpoint*. The object of the research for this paper was to investigate the flow characteristics during the exhaust blow-down and to develop a rational background for designing and improving the present poppet type exhaust valves of aircraft and automotive engines. The whole research was carried out in three main steps: (1) theoretical study of gas flow through exhaust valves; (2) experimental study of gas flow coefficient during exhaust blow-down; and (3) correlation and discussion of the data obtained.

A series of modifications on profiles of valves and seats were investigated. The topics are (1) stem fillet, (2) inner rounds, (3) outer rounds, (4) head enlargement, (5) seat angle, and (6) profile of port approach. The records of their effects on valve performance were grouped, compared, and explained both graphically and theoretically in order to give a sound basis for the exhaust valve design. The pressure range investigated extends from critical pressure (atmospheric pressure/0.53) up to 80 lbs. per sq.in. It covers the actual operating conditions of all the modern unsupercharged and moderately supercharged aircraft as well as automotive engines. Experiments, agreeing with the theory, indicate that the flow coefficient is almost independent of, and increases slightly with, the initial pressure. The results of this research, therefore, can be successfully applied on the safe side to the prospective highly supercharged engines with an exhaust pressure higher than 80 lbs. per sq.in. The most interesting part of the paper lay, naturally, in the author's conclusions, which he summarized as follows:

"(1) Through a simple modification on a conventional valve, such as a valve from the C.F.R. engine, the maximum flow rate, within the most useful range of the valve lift, can be increased at least by 25 per cent. Such a gain could be obtained with no additional cost, since neither the diameter of the valve nor the size of the port need be changed.

"(2) The optimum valve found has a 30° seat angle, with slight head enlargement, rounded at all corners with moderate radiuses, and seated on a port shaped as a converging orifice. At moderately high valve lift, take $L/D = 0.3$ as an example: its flow coefficient is about 0.82, which is 94 per cent of that of an ideal orifice with the same net opening area (= area of port − area of stem).

NEITHER SNOW NOR RAIN NOR HEAT . . .—



Bitter cold, raging storms and blistering heat are all taken in stride by Pan American Airways as it speeds vital war materials north, south, east and west to the far corners of the earth.

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"(3) The maximum useful valve lift for the optimum valve found is about 28 per cent of its port diameter. However, for a conventionally shaped valve, the lift should be designed as high as feasible, since the flow coefficient increases steadily with the valve lift, even when the L/D ratio is as high as 0.45.

"(4) Within the pressure range investigated (from critical pressure to 80 lbs. per sq.in.), the flow coefficient is practically independent of the pressure drop across the valve. Therefore, if the exhaust valve of an aircraft engine is designed for sea-level condition and shows efficient performance during its ground test, it would so remain regardless of flying altitude, manifold pressure, or degree of supercharging. From the same point of view, it would seem that all the results of this paper could be successfully applied even to prospective highly supercharged engines with an exhaust pressure higher than 80 lbs. per sq.in.

"(5) Regarding profile modifications, the results may be summarized as follows: (a) Stem fillet—The effect of a stem-to-head fillet of an exhaust valve is negligible from gas flow standpoint. (b) Inner corner rounds and outer corner rounds—Flow performance can be greatly improved by rounding the inner and outer corners of the valve, the former being more effective. (c) Head enlargement—By enlarging the valve head, the flow coefficient can be slightly raised at low valve lifts. (d) Seat angle—A 30° seat angle is favorable at low valve lift; a 45° seat angle, at high valve lift. (e) Profile of port approach—To shape the profile of the port approach as a converging orifice increases the flow capacity appreciably at high valve lift."

Direct-Reading Torquemeter

J. C. Luttrell, Air Transport Command, Army Air Forces; and W. A. Petrasek, American Airlines, Inc., discussed *The Horsepower Meter for Aircraft*. The horsepower meter described in the paper answers the problem of suitable instrumentalization for torquemeter operation of aircraft engines. Operation by chart horsepower is unsatisfactory. The torquemeter technique eliminates many corrections and gives far more reliable operation. The pressure from the torquemeter varies a resistance inversely as pressure and, when set, the resistance is connected in series with the engine tachometer, generator, and ammeter which is calibrated to read in units of brake horsepower. Many advantages are claimed for this direct-reading torquemeter. Among these is a greater check on engine operation and power, particularly during take-off.

Turbine Supercharger Installations

Philip Colman, of Lockheed Aircraft Corporation, in *Temperature Effects on Turbine Supercharger Installations* dealt effectively with the complex phenomena involved and presented a complete analysis and correction charts so that the reduction of test data from flight testing to the airplane would be both more accurate and reliable.

Radio and Instruments

Engine Testing

Paul J. Campbell, of United Aircraft Corporation, described *A Multiple Recording Manometer*. In testing aircraft-engine installations in the full-scale wind tunnel, it has become necessary to develop new methods of observing and recording data. Such experimentation is concerned in a large measure with the flow of air through various internal passages and cooling devices and over the external surfaces of the nacelle. This means the measurement and recording of pressures at many locations. In fact, the number of such pressures to be recorded for each reading may exceed 100 on an average test. Because of the high cost of testing and the value of time, it is important that these pressures be recorded in a mimimum time.

Most pressure-recording instruments are generally unsuitable for aircraft-engine research because they have been designed to record the time variation of one or two pressures rather than the momentary value of a large number of temporarily fixed pressures. Photographic manometers have been used with advantage in wind-tunnel work but with the disadvantages that the record is not available for some time after it has been taken and that the manometers are troublesome to connect.

The Research Division of United Aircraft undertook the development of a new manometer. Its elements include a number of limp diaphragms to each of which is applied one of the pressures to be recorded, a compressor and regulator for applying of varying pressure to the back of the diaphragms, and a recording system to indicate on a chart the pressure necessary to balance each diaphragm against the pressure it is to measure.

In operation, the pressure regulator automatically varies the balancing pressure, which is applied simultaneously to the back of all diaphragms. A recording arm moves, as this pressure is varied, in such a way that its displacement is always precisely in proportion to the balancing pressure. The arm carries one stylus for each pressure to be recorded. The mark made by the stylus is controlled by an electrical circuit through the corresponding diaphragm. As the balancing pressure is gradually increased, it exceeds, one by one, the pressures on the opposite side of the diaphragms and, as it does so, the electrical circuit through each is broken. Since the stylus is arranged to record only while its electrical circuit is closed, it marks on the chart a line whose length is proportional to the pressure measured by the diaphragm.

Connections between the diaphragm cell and the recorder consist of one tube to transmit the balancing pressure and a multiwire cable to carry electrical current from the diaphragms. The diaphragms are mounted in the nacelle and connected by small rubber tubes to the various points where pressure is to be measured.

The instrument has proved remarkably satisfactory in operation and makes a complete record in 1 min. For engine testing, this speed is fast enough because the engine must be held at constant conditions for longer than a minute to permit temperatures to be recorded. The greatest observed error has been 0.4 per cent of full scale.

The Magnesyn Compass

It is extremely important in present-day aircraft that magnetic compasses be located in a place as free as possible from local magnetic disturbances. Donald W. Smith, of the Pioneer Instrument Division, Bendix Aviation Corporation, described in full its *Magnesyn Remote Reading Compass*. The instrument is described in detail, the elements required including a transmitter and receiver or indicator. With proper excitation and coil conditions the rotation of the transmitter magnet will cause the receiver magnet to follow in the same direction and with the same angular displacement.

The paper dealt exhaustively with the theory of the harmonic flux developed, relationship between rotor position and voltages, and the like. The system has proved reliable and flexible, light and compact. There are no moving parts between the compass element of the transmitter and the compass indicator, and there is maximum simplicity of design.

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Vultee Radio Recorder

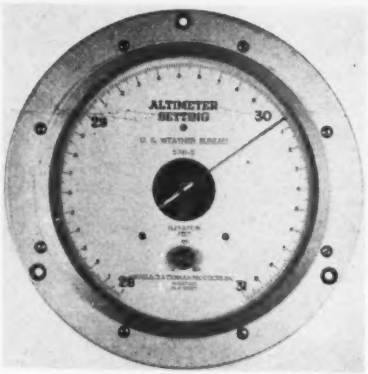
Harvey D. Giffen, of Vultee Aircraft, Inc., described the *Vultee Radio Recorder*, which enables this instrument to record the indications of instruments on board the aircraft which are converted into related audio frequencies that modulate the carrier wave of the airplane's transmitter.

The transmitted instrument signals are picked up at a ground station and are recorded and decoded. The amplitude of a total of 72 different instruments such as strain gauges, temperature bulbs, pressure units, and flight instruments can be taken at a maximum speed of $^1/_{100}$ sec. per instrument. The use of varying audio frequencies to represent instrument deflection overcomes amplitude variations in the radio carrier wave due to fading and produces a permanent record in a form that lends itself to automatic chart plotting. An automatic analyzer that decodes and produces separate charts for each instrument is described.

There are now from 50 to 100 factors involved in determining the performance of the airplane. These factors include flight instrument education, temperature and pressure readings, atmospheric conditions, fuel flow, throttle flap and control positions, etc. Difficulties and complexities are involved. Test of the Vultee recorder has definitely shown that the equipment has eliminated human errors and speeded up greatly full flight-test operations. It is a great advantage that the existing radio equipment can be used. The additional equipment scans the various pickups and converts their readings into corresponding audio-frequency oscillations that are fed into the microphone input of the airplane transmitter. The ground equipment receives these signals and records them by several methods —sound film, disc recorder, and graphic recorders.

Altimeter Setting Indicator

Charles H. Colvin, of New York University, in his paper on *Altimeter Setting Indicator*, described an instrument developed under the author's direction which meets a long-felt need. To understand why such an instrument is needed, it is necessary to recall that the sensitive altimeter, as used on all transport and military aircraft to indicate altitude, is provided with a so-called barometric scale, by means of which the instrument may be adjusted to compensate for barometric pressure changes. In a flight this scale is set by the pilot to the number of which he is advised by radio from an airport. If the barometric scale is set to this number the hands of the altimeter will read the altitude of the airport when the plane



Altimeter setting indicator. (From *Altimeter Setting Indicator.*)

lands on that airport. The number to which the pilot sets the barometric scale of the altimeter is known officially as the "altimeter setting number" and, colloquially, as the "Kollsman number."

The new altimeter setting indicator is intended for installation at airports and is a special form of an aneroid barometer in which the mechanism is so designed and the scale so graduated that the altimeter setting number is read directly. An adjustment is provided for adapting the instrument for use at airports at various elevations above sea level. The great advantage of the new instrument, which can be installed in the operations office rather than in the weather bureau office, is that it can be read at any time by operating personnel and the altimeter setting number transmitted immediately without reference to the weather bureau office and without any more or less lengthy calculations.

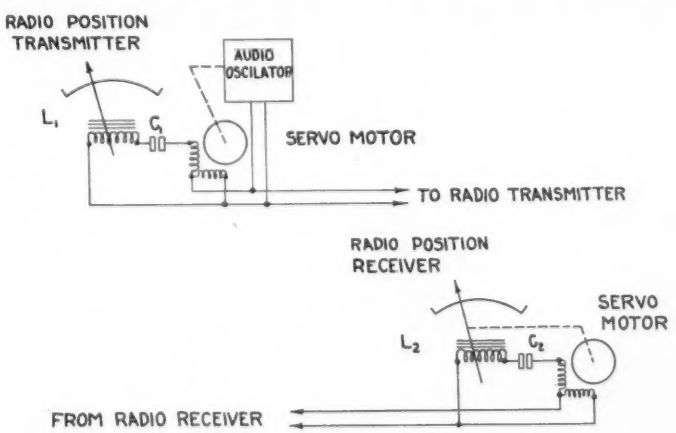
Air-Speed Indicators

Kalman J. DeJuhasz, of The Pennsylvania State College, in *Graphical Analysis of Delay of Response in Air-Speed Indicators*, has devised a method of graphic analysis in which the causes and magnitudes of the delay can be analyzed even when the cases are too difficult for purely mathematical analysis. (This paper was printed in full in the March issue of the JOURNAL—ED.)

Control Systems

David W. Moore, Jr., of Fairchild Aviation Corporation, described interesting and novel *Resonant Electrical Control Systems.* Remote positioning and control equipment have become essential features in the design of modern aircraft. The increasing size of planes has complicated the control problem. By lengthening the distance between the various control and accessory components, flexible shafting and mechanical linkages tend to become impractical for large aircraft. The difficulties, both of flexible shafting and of the linkages, are obvious. To meet the problem, various positioning and control systems have been developed, such as the Selsyn position repeater. Devices of this character are efficient and accurate for indications that do not require the development of any appreciable amount of torque, since the electrical system employed is too elastic for supplying substantial torques with accuracy. Power-producing position-repeating systems have been developed, but they require contacts and relays for their operation and may become unsatisfactory from the maintenance point of view. Moreover, these contact-operated controls are of the so-called "on-off" type. They do not produce control torques proportionate to the input error signal and may hunt if adjusted to permit high sensitivity.

The paper describes a new position-repeating and control system that is based upon the change in the phase relationship between current and voltage in a series resonant circuit as the tuning of the receiving circuit is varied.



A radio transmission system capable of definite proportionate position control over a radio carrier. (From *Resonate Electrical Control Systems.*)

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The control system's sensitivity is a function of the Q of the resonant circuits employed (that is, a function of the efficiency of the electrical circuits) and is high for values of Q which may be easily obtained in normal practice. The paper discusses the application of this principle to the control of low and substantial amounts of power, and practical circuits are proposed. No electrical contacts are required in any of the circuits which permits the design of an extremely reliable instrument. The author concludes with a brief description of the application of this resonant control principle to single- and multiple-channel resonant control.

Rotating Wing Aircraft

Helicopter Progress

Igor I. Sikorsky with his paper *Progress of the Vought-Sikorsky Helicopter Program in 1942* showed a remarkable film which gave the most astounding proof of the complete maneuverability and controllability of his design. Spot landings, picking up of parcels, descent from a helicopter by rope ladder, and other remarkable achievements astounded the audience though actual technical data had of necessity to be withheld.

Rotor Control

E. Burke Wilford, of the Pennsylvania Aircraft Syndicate, Ltd., in *Control for Helicopter Rotor* classified the various types of control which may be used for rotating wing aircraft as follows: "(a) Cierva—hinged blade with tilting axis control; (b) Hafner—hinged blade with feathering control; (c) Herrick—rigid rocking blade with rotor control; (d) Wilford—semirigid blade with feathering control." The features of these various systems have already been fully described in the author's paper of December, 1939. Some simple rules of thumb regarding angles required for satisfactory rotor control were given.

Performance Calculations

The two papers—*Helicopter Performance Calculations* by Quentin Wald, United Aircraft Corporation, and *Aerodynamic Considerations of Rotors in Hovering and Vertical Climb Conditions* by Charles H. Kaman, Hamilton Standard Propeller Division, United Aircraft Corporation, dealt with closely related topics in highly contrasting fashion.

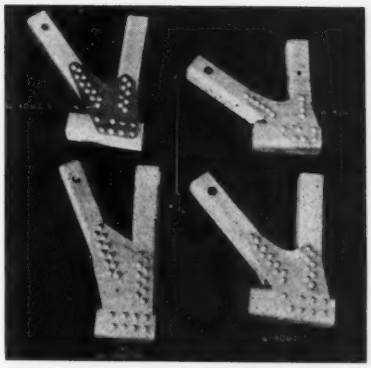
Wald attempted to supplant exhaustive and complex analysis of helicopter performance by a relatively simple method based on the conception of the rotor as an actuated disc and the well-known momentum rules for an actuated disc. Kaman, on the other hand, with great courage and equally great belief in the vortex theory of the propeller as applied in aerodynamics, applied the work of the English investigator Goldstein to the needs of the helicopter. With this application of the vortex theory he presented a comprehensive method of computation in which all variables can be taken into account. As an illustration of his theory he included a study showing optimum distribution of blade width and lift coefficient parameter for two-, three-, four-, and six-blade rotors operated at or near hovering speed. The results showed that a highly tapered blade is desirable and that the load distribution shifts slightly toward the tip with increasing number of blades. The papers by Wald and Kaman deserve careful study by those interested in the helicopter art. However, neither of the authors has yet closed the problem. The complexities of helicopter performance calculations are such that many years of theoretic, analytic, and experimental work will be necessary before helicopter performance computations can be made with confidence.

Structures

In the Structures Session a number of highly pertinent papers were presented covering many aspects of structural analysis and design. Most of the papers, as might well be expected, were of a highly mathematical or analytical character, not lending themselves readily to this summary. However, an attempt will be made to present the basic ideas involved.

Effects of Perforations

One of the items which continually annoys the stress analyst today is the holes, cutouts small or large, which the designers persist in introducing into the skin cover of wings and fuselage. In fact, it is surprising at times, when the holes in the structure of an airplane are considered, that it stands up at all



Typical tension failures in gussets. (From *Tension Joints in Aircraft Structures.*)

under heavy loads. Richard K. Koegler and Arthur Schnitt, of the Airplane Division, Curtiss-Wright Corporation, removed some of the difficulties by their paper *Effects of Yielding and Perforations on Wing Tension Surface.* The paper really presented two different though interdependent ideas in stress calculation. The first part of the paper dealt with the perforation effects on stress-strain curves. The authors presented a method of calculating such curves for any gauge length and perforation size and spacing. The method depends on an "effective perforation length" and an ultimate stress concentration factor. Test data were presented to substantiate the method. Tentative curves were also presented from which the effective perforation lengths and stress concentration factor for various perforations can be found for use in engineering calculations. The authors summarized the comparative behavior of perforated aluminum-alloy specimens and solid specimens as follows: The stress-strain curve for a perforated specimen based on the stress across the solid or gross section has a slightly lower modulus of elasticity in the elastic range, a lower yield point, and lower stress at all strains in the plastic range. The ultimate elongation is reduced, and the ultimate stress across the perforated or net section is reduced because of stress concentration. The shape of the stress-strain curve, the ultimate elongation, and the degree of stress concentration are functions of the size and spacings of the perforations and of the elastic and plastic properties of the solid material.

The second problem dealt with accounting for yielding in ultimate strength calculations. It consists of applying stress-strain curves to the strain distributions found in elastic range. Its practicability and validity depend on the fact that in the plastic range the stresses determined will not be seriously in error for moderate variations of strain. Examples based on a

two-beam wing with heavy 24S-T extruded flanges show that calculations neglecting yielding may indicate failure in the wrong member and at too low a load (15 per cent in a typical case). In addition, if an appreciable length of surface yields, "shear lag" may be seriously affected.

The method applies to many cases besides the one shown. Because of the slow increase of stress with strain after yielding, approximate calculations afford reasonably accurate results, and it may be found in the future that yielding effects will simplify many stress calculations rather than complicate them.

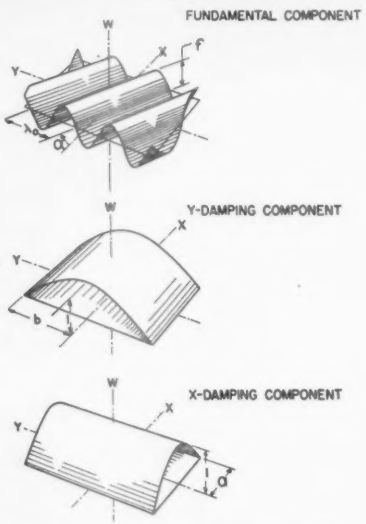
Bending Strength

The ordinary simple beam theory has been so long accepted by engineers that they sometimes forget its limitations and, when its limitations, as in the plastic range, have to be considered, they are somewhat at a loss. Frank P. Cozzone, of Lockheed Aircraft Corporation, undertook an investigation of *Bending Strength in the Plastic Range*. The method, based on reasonable assumptions, substitutes for the conventional linear distribution of stress in the plastic range as represented by the classic formula Ny/I, a simple trapezoidal distribution that varies with the applied bending moment. The trapezoidal distribution is an approximation based on the actual stress-strain characteristics of the material and the shape of the cross section. The method takes in the following points: (1) the resisting moment of any cross section corresponding to any extreme fiber stress up to the ultimate stress of the material, (2) the corresponding stress distribution over the entire cross section, (3) the corresponding shear distribution, (4) the effects of local crippling, (5) complex bending, and (6) the combined effects of axial load and bending.

Working charts or graphs to help in application are also presented, each of which is applicable to a particular material. For each of the six points investigated a definite procedure is offered in engineering form in the author's excellent summary. Some of the work is based upon theoretic or design considerations, some on tests. The author has taken particular pains to take into account such things as shift in the neutral axis and local crippling and the like, which are so frequently excluded. The paper is one that will be studied in every engineering office.

Structural Design

For a good many years, in considering the strength of columns, men versed in applied mechanics and structural designers have made allowance for the fact that when materials are used in columns at high stress levels exceeding the proportional limit a reduced or tangent modulus of elasticity has to be employed. The reduced modulus, which produces a formula that takes into account the actual reduction of the modulus because the tangent modulus may be less than the initial or Young's modulus, dates a good many years back in European literature and has been well developed in application to solid rectangular sections. Such sections, however, have a limited application in aircraft work and, accordingly, Don S. Wolford, of the American Rolling Mill Company, in his paper on *Significance of the Secant and Tangent Moduli of Elasticity in Structural Design*, has done an excellent job in extending the formulas for solid sections to include the additional cases of hollow section. He derives the double modulus formula for a hollow section acting as a column. Column tests on corrugated sheets of high-tensile stainless steel were described and indicate that the tangent modulus can be used for the reduced modulus and probably will give sufficient accuracy in column design of such materials. Mathematical derivations are given showing that the deflections of hollow beams subjected to pure bending are proportional to the secant modulus. The methods of determining the initial, secant, and tangent moduli on high-tensile stainless steel are given along with curves for converting them to the proper reduced modulus. The anisotropic nature of cold-reduced stainless steel is shown to be less significant in columns than would be expected by direct comparison of tangent modulus data.



Components of web deformation. (From *Strain Energy Analysis of Incomplete Tension Field Web-Stiffener Combinations.*)

Monocoque Cylinders

N. J. Hoff, of the Polytechnic Institute of Brooklyn, in his paper *General Instability of Monocoque Cylinders*, well defines general instability as the simultaneous buckling of the longitudinal and the transverse reinforcing elements of a monocoque structure. Of course the definition, strictly speaking, applies only if the cylinder (wing or fuselage as the case may be) has both longitudinal and transverse reinforcements—in other words, if the cylinder is a semimonocoque. The author, however, rightly contends that the word "monocoque" can be used in place of the more cumbersome "semimonocoque." In fact, we build so many semimonocoque structures and so few true monocoques that no harm would result, at least at the present, if "monocoque" were used generally instead of "semimonocoque." Not the least valuable part of the paper were the excellent definitions given by the author of the various types of instability which he investigated. In fact, the mathematical methods he employs or suggests cannot be entered into and it is necessary to be limited to these definitions:

(1) Flattening in compression—"A monocoque cylinder loaded with uniformly distributed compressive forces may fail by flattening. 'Flattening' means that the originally circular rings (transverse reinforcing elements) distort to ellipses, and the originally straight stringers (longitudinal reinforcing elements) to sine curves of one or more half-wave lengths."

(2) Diamond pattern in compression—"The deflections are sinusoidal in both the longitudinal and circumferential directions and usually consist of several half-waves in either direction. The pattern is much the same as the one well known from the buckling of thin-walled nonreinforced circular cylinders. By definition, the half-wave length in the longitudinal direction must be greater than the spacing of the rings if the buckling is to be classified as general instability. The flattening discussed under (1) is just that special case of the diamond pattern when the number of half-waves is four in the circumferential direction."

(3) Flattening in bending—"An isotropic thin-walled circular cylinder flattens to an elliptic shape when a pure bending moment is applied to it. The flattening increases gradually when the applied moment is increased, and the cylinder collapses when the moment reaches its critical value."

(4) Inward bulge in bending—"Because of the lack of a better expression this name has been chosen to indicate that the characteristic feature of this type of buckling is an inward bulge that

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develops symmetrically to the most highly stressed fiber in compression. In some cases secondary bulges also appear and the deflected shape slightly resembles the diamond pattern in compression described under (3). However, deflections are greatest near the most highly stressed fiber in compression, they decrease in magnitude toward the neutral axis, and the tension side of the cylinder remains smooth."

In each of these cases the author coordinates theory with experimentation and suggests definite methods of analysis.

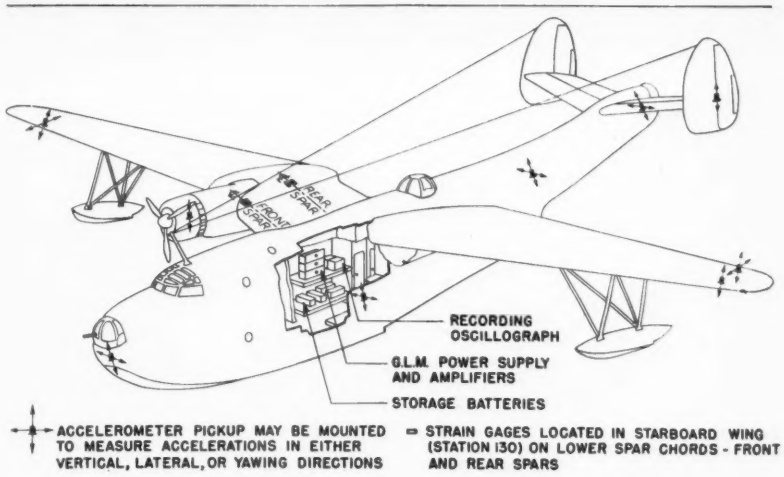
Columns and Plates

A great many formulas have at various times been used and still more suggested for the buckling of aluminum alloy columns and plates. The formulas for stringers in combination with plates are even more numerous. Theoretic treatment in itself is insufficient; nor are pure tests sufficient. The correct approach is to undertake systematic tests and coordinate them with theory. That is exactly what Henry L. Langhaar, of Consolidated Aircraft Corporation, has done in his work on *Buckling of Aluminum-Alloy Columns and Plates.* A large number of column tests of 24S aluminum alloy were conducted. The specific purpose of the tests was to obtain experimental curves to supplant empirical criteria, such as the Johnson parabola and the straight-line approximation in the design of plain columns. By use of the effective-modulus theory the data have also been used to predict buckling stresses for plates. The tests were made with case-hardened semicylindrical steel roller heads, while the ends of all columns were ground flat and parallel. The roller head column assisted in defining the effective lengths. Column stresses were plotted against slenderness ratios and the adaptation of formulas closely followed experimental results. In the study of effective widths of plates active with stringers it was assumed that the stress distribution between consecutive rivet rows is a simple sine wave with a maximum value of stress on the lines of rivets and the minimum value midway between the lines of rivets.

Tension Joints

While a good deal of technical literature has been devoted to panel design and the design of compression surfaces, little attention has been paid to the subject of tension surfaces and tension joints. No doubt it has been tacitly assumed that tension joints, riveted of course, can be calculated on the well-understood lines of conventional riveted work. Clarence Holleman, of the Boeing Aircraft Company, rightly questions this assumption and investigated the point in his paper on *Tension Joints in Aircraft Structures.* The author presents data to establish the effect of holes on the tension efficiency of 24S-T aluminum alloy. He finds that the conventional assumption as used in the design of riveted structural steel joints are not fully applicable to riveted joints in aluminum alloys. Allowances must be made for the reduced efficiency of perforated aluminum-alloy sheet which results from stress concentration at the edges of holes in the sheet. If maximum efficiencies are to be obtained, the size, spacing, and position or pattern of the rivets must be carefully selected. Information was presented on the effects of hole size, hole type, number and spacing of holes, number of rows, and amount of stagger. Full discussion and information is presented under each of these headings. Some information is also given on efficiency of spot-welded joints in aluminum alloys. It was found possible to obtain approximately 80 per cent efficiency with a spot-welded joint. The spot-welded joint illustrates several of the principles emphasized in the foregoing discussion of riveted joints. Since the welded spots are capable of but little yielding, it is essential that differential elongation of the two sheets be avoided. With equal gauge sheets this can be done if only two rows of spots are used. However, insufficient shear strength is developed by two single rows of spots, so two double rows are used. By keeping the first and second rows of spots close to each other, the differential elongation of the two plates is kept sufficiently small to avoid shear failure of the spots in the first row.

In general it has been found desirable to avoid staggering the spots in the double rows. The annealing effect of the heat used in the spot-welding operation causes a weakening of the sheet similar to that caused by the holes in a riveted joint. As in the case of riveted joints, therefore, it is desirable to provide a direct path through the uninjured sheet material for the transfer of load across the double row of spots. Staggering the spots would appear to produce a tortuous path with resulting high stress concentrations.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ACCELEROMETER PICKUP MAY BE MOUNTED TO MEASURE ACCELERATIONS IN EITHER VERTICAL, LATERAL, OR YAWING DIRECTIONS
STRAIN GAGES LOCATED IN STARBOARD WING (STATION 130) ON LOWER SPAR CHORDS - FRONT AND REAR SPARS

Installation of acceleration measuring equipment in the Model PBM-3 airplane. (From *Experimental Investigations in Aircraft Dynamics.*)

Strain Energy Analysis

Strain Energy Analysis of Incomplete Tension Field Web-Stiffener Combinations by Paul H. Denke, of Douglas Aircraft Company, Inc. In the "tension field" or "Wagner" beam, comparatively thin webs are designed to buckle within their working range. For small shears, as the author pointed out, the web remains flat and the laws of plane stress apply, but, when the sheet under heavy load buckles into a series of diagonal wrinkles, the stresses existing in the member can no longer be predicted by the theory of plane stress. The problem then is to find a method of analysis whereby the actual stress distribution in a thin web beam operating beyond the critical can be computed. It is the purpose of the paper to present a minimum potential energy analysis of thin web beams subjected to shear loads above critical. The wave form of the buckled surface is approximated by a function that contains the wave length, wave angle, and wave depth as parameters. Four more parameters —namely, the stiffener compressive strain, the cap compressive strain, the cap bending deflection, and the panel shearing strain—are introduced, and the distribution of the mid-plane tensile, compressive, and shear stresses is worked out. The energy of the entire

(*Continued on page 137*)

"You can't fly a Beam to Dakar"

"COMPARED TO THIS OCEAN-HOPPING, flying a transport over the Blue Ridge was duck soup. All you did then was hang onto a beam. But, brother, it's different now. There aren't many signposts on the way to Africa except the dials on your instrument panel. And when there's nothing in sight but salt water, those dials are mighty comforting.

"After the war, I guess I'll be back behind the wheel of a passenger plane again but I'll probably still be flying by instruments . . . in the stratosphere . . . non-stop from coast-to-coast. Well — as long as I've got instruments I can depend on, I'll say that's the way to get there."

WHAT TOMORROW'S PLANES *will look like or how they will perform, we don't exactly know. But we do know that Kollsman research engineers are constantly planning and developing new and better precision aircraft instruments . . . to help smooth out tomorrow's skyways, and give safer wings to a nation at peace.*

THE KOLLSMAN SENSITIVE AIRSPEED INDICATOR, *used for close navigation and precision bombing, has a range of 700 m.p.h., and can be read to within a few miles per hour at any speed.*

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Progress of the Vought-Sikorsky Helicopter Program in 1942

I. I. SIKORSKY*

United Aircraft Corporation

ONE YEAR AGO, the author outlined at some length the developments of 1941 when an International Helicopter Endurance Record was established by the experimental VS-300 helicopter and when three totally different types of control were installed and tested on the ship during the calendar year. As a brief review of the last report, the control arrangement of the helicopter during the first half of 1941 consisted of three auxiliary propellers, two of which were mounted on lateral outrigger extensions at either side of the rear fuselage and provided longitudinal and lateral control, while the third was mounted vertically at the extreme tail of the fuselage and provided torque compensation and directional control. The arrangement proved satisfactory for hovering but developed some unfavorable qualities in forward flight and required a rather complicated structure and mechanism. In the summer of 1941, a cyclic pitch change for lateral control was installed in the main lifting rotor, and the two lateral auxiliary propellers were replaced by one tail propeller on a vertical shaft, which provided longitudinal control. This arrangement gave satisfactory results and encouraged the next step: the introduction of full cyclic pitch control for both longitudinal and lateral controls, leaving only one auxiliary propeller for directional control and torque compensation.

Full Sectional Control

At the time of the last report, this latter installation was just being investigated, and the writer was only able to report that "flights with full sectional control had so far been entirely satisfactory." It can now be stated that full sectional control (or "cyclical pitch" control) has been employed on the VS-300 during the entire past year and has proved to be excellent. The craft has now reached a stage where it may be stated that all major problems of the single main rotor helicopter have been solved. Naturally, there will be endless refinements and simplifications that will be made in control, transmission, structure, and general design, but the fundamentals of the single main rotor helicopter have been established, and it is now a flyable and practical type of aircraft.

Presented at the Rotating Wing Aircraft Session, Eleventh Annual Meeting, I.Ae.S., New York, January 25–29, 1943.

*Managing Engineer, Sikorsky Aircraft Division.

The experimental VS-300 helicopter.

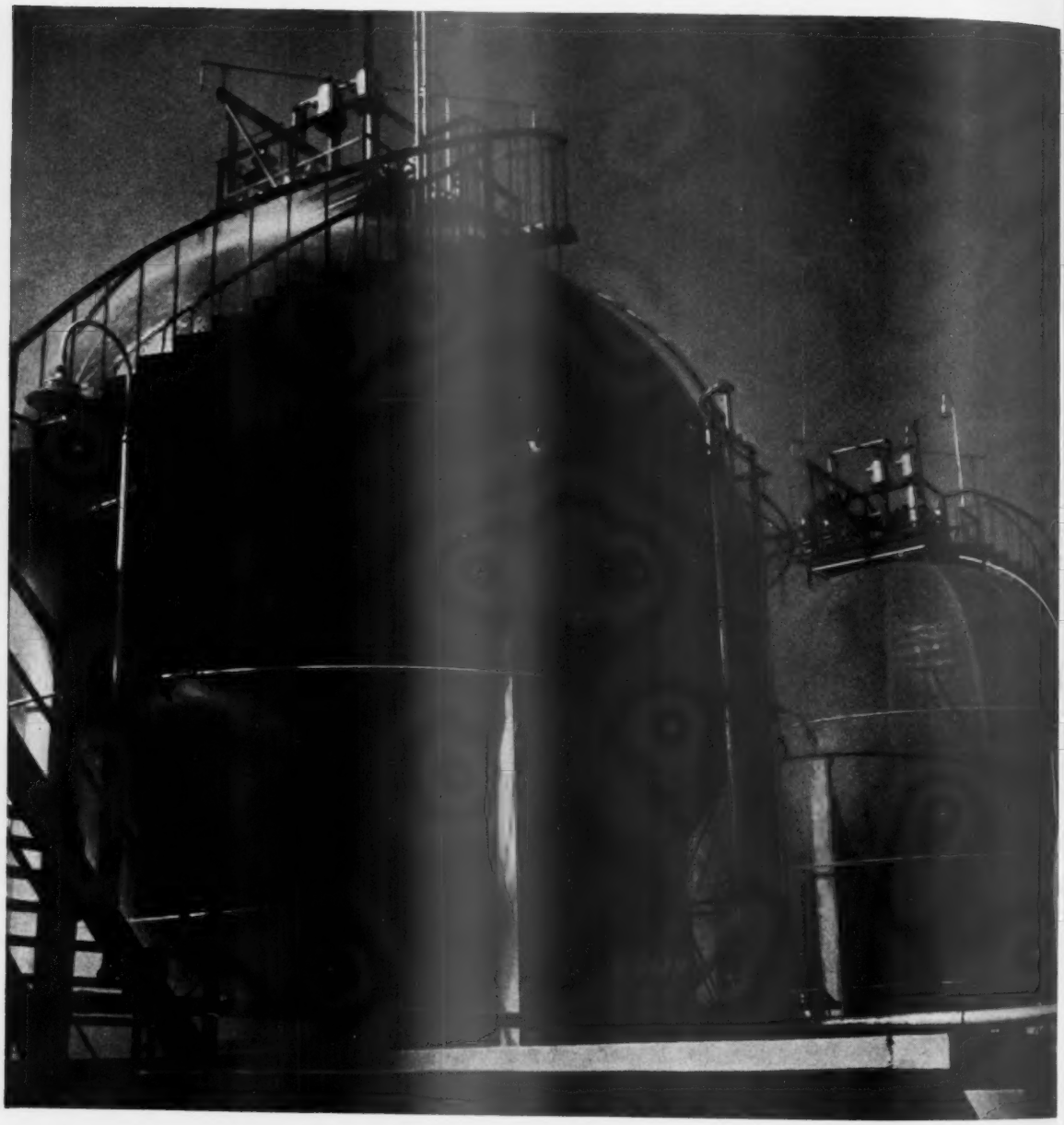
Accuracy of Control

During 1942, the VS-300 has proved itself to be totally controllable and completely flexible in its utility. Among the most interesting achievements of the year has been the definite proof of its unprecedented and outstanding accuracy of control in direct comparison with any vehicle moving in a fluid medium, whether it be an airplane, a dirigible, a surface vessel, or a submarine. Figuratively, the cause of this precision control can be compared with the action of a micrometer screw in which the accuracy comes from the use of a large movement in the handle which results in only an extremely small movement of the operating mechanism. In the case of an airplane or dirigible or steamship, the sensitivity and power of the rudder control depend on the forward velocity of the craft, while in the helicopter, which may move at 80 or 8 or even zero m.p.h., the control is determined by the tip speed of the rotor blades, which are always moving at a speed in the neighborhood of 300 m.p.h. This factor furnishes a reliable foundation for perfect control characteristics under all conditions of flight.

Maneuverability

The helicopter is capable of hovering and flying backward and sideways, as well as forward, with a smoothness of operation that is noticeable not only from without but also from the pilot's seat. Its ability to fly at literally any speed from zero to a maximum of approximately 80 m.p.h., as well as to turn or come to a full stop in a remarkable short space, is only one demonstration of its flexibility. Added to this is the fact that, mounted on inflated rubber pontoons, the craft has unequalled amphibian characteristics. It can, of course, operate quite readily either from land or water on these pontoons without the need of wheels. Also, this installation has permitted landing on mud, on ice, and on snow. It has repeatedly been landed on a small roof and on a pile of engine packing boxes on the company ramp. Recently, a series of landings were made in a deep gully with high banks and piles of dirt on each side, with boats surrounding the spot and with part water and part mud at the bottom. Under all these conditions there has been not the slightest indication that any undesirable developments might arise.

The major effort throughout the year has been toward a more complete



AMERICA'S WAR PRODUCTION DEPENDS ON TANKS LIKE THESE

Take a good look at these huge spherical tanks. Chances are your hose, your belts, your packings may come from them or from others just like them.

These are used for storing butadiene in the first of the synthetic plants operated by U. S. Rubber Company . . . a second will soon be in production.

Having worked in the field of synthetic rubber since 1921 we know what uses each of the five basic types of synthetic rubber is best suited for . . . Neoprene, Buna-S, Buna-N, Butyl and Thiokol . . . U. S. Rubber uses all five types . . . knows which one to select for the performance required . . . and how to compound the specific synthetic rubber for the specific task. This experience is important to you.

Our booklet on synthetic rubber will give you much valuable information. Send for your copy.

Mechanical Goods Division

UNITED STATES RUBBER COMPANY

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investigation of controls and rotor phenomena. Nevertheless, in the early fall, some experiments were made with a two-bladed main rotor. These were undertaken because of the obvious simplification of main rotor hub and control installations and also because of the fact that it would eliminate the need for folding the blades in order to store the craft in a small space, since with the twin-blade rotor the blades could be stopped over the longitudinal axis of the fuselage and the area required would then be governed only by the width of the undercarriage and the length of the craft. The craft proved to be quite flyable with a twin-blade rotor. A moderate lateral vibration at a frequency of twice-per-rotor-revolution has been the primary difficulty experienced with the twin-blade rotor and, therefore, it cannot be stated at present whether or not the twin-blade rotor may replace the three-blade rotor.

One demonstration of the excellent controllability of the XR-4.

Conclusion

A recent public announcement from Wright Field stated that a Vought-Sikorsky helicopter had been delivered to the Army Air Forces at Dayton. Designated as the XR-4, the craft embodies the same fundamentals of control and structure that have been worked out on the VS-300. It is a two-place helicopter and was first flown on January 14, 1942. On May 13, it took off from Stratford on its delivery flight to Wright Field. This trip was made by easy stages and, aside from the turmoil that was created at the airports where it landed, it was reasonably uneventful. But at each airport the qualities of this strange aircraft caused unconcealed astonishment. The pilot's chief difficulty was with the control towers. When he flew up to them and hovered nearby, awaiting instructions, they sometimes kept him there a full minute before they recovered sufficiently to signal him down. The usual signal finally was a violent waving of the hands, which indicated that he was cleared for landing. The ship would then settle gently at the base of the tower. As soon as the gas pump was located, the pilot would take off, fly the few intervening feet, and land beside the pump, which at times was surrounded by parked airplanes. When the craft was to be housed for the night, the pilot would land on the ramp in front of the hangar doors. Occasionally, he would intentionally overshoot the ramp by a few feet, after which he would back up and land on the mark.

Adverse weather conditions were encountered during the trip, including strong head winds with gusts up to 35 m.p.h., heavy rains, low ceilings, visibilities of less than a mile, and turbulence in the vicinity of thunderstorms. None of these conditions produced even a hint of undesirable results in the craft, and in the low ceilings and reduced visibility the craft was slowed down so that contact flight was maintained at all times and in perfect safety.

The craft arrived at Wright Field and was accepted by the Army after a series of demonstration flights the latter part of May. It may therefore be stated that the year 1942 saw the helicopter rapidly emerge from the status of a highly experimental development to the status of a full-fledged flying craft.

This ship had never gone farther than one mile from the point of take-off and had never been flown at an altitude of more than 150 feet. Within the first five months of 1942, these accomplishments had been increased to the 760-mile trip from Stratford to Dayton, with the craft frequently flying at altitudes of several thousand feet.

Perfect stability in hovering flight is a characteristic of this new type helicopter.

Sub smasher

To smash a sub, you first find the sub. That takes a fairly large bomber with a fairly long range, for oceans are big and subs are small.

After you find your sub you go into a power-dive, *quick*, and drop your bombs. U-boats now crash-dive in just 20 seconds. Ordinarily you can't do much of a power-dive with a medium bomber —not and stay in one piece.

But you can in a Lockheed Hudson bomber! Lockheed Hudsons hold the official RAF Coastal Command record for having smashed more subs than any other warplane.

The reason is simple. The Lockheed *Hudson*, like the Lockheed *Lightning* and the Vega *Ventura*, was designed, engineered and built to provide *extra* strength and *extra* dependability. It has been used by the RAF longer than any other American bomber.

for protection today, and progress tomorrow, look to

Lockheed

FOR LEADERSHIP

Vega Ventura
medium-range bomber

Lockheed P-38
Lightning fighter

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Passive Defense—The Protective Armoring of Military Aircraft

HORACE J. ALTER*

Summary

Armor plate is required for protection on airplanes to keep personnel and matériel losses to a minimum and within the limits of supply. The vulnerability of aircraft, it is stated, depends upon the types of gun installations in the opposing airplanes and the relative approach angles of the two airplanes. A graphic analysis of attacks from various angles is presented for both fixed and flexible gun fighters. It is concluded that the rear of the attacked airplane will be subjected to more gunfire than any other portion of the airplane. Attacks originating from 75 per cent of the sphere will develop into pursuing actions or, for the flexible gun fighter, into a pursuing, leading or lateral action. The remaining 25 per cent will be frontal attacks, which are likely to be discontinuous or broken off after a few seconds of combat. Areas requiring protection and methods of protection are described for crew members, power plant, and vital equipment.

Introduction

The airplanes of the United Nations, thus far, have shown one distinctive advantage over those of the Axis Trio in that adequate protective coverings in the form of armor plate, bullet-resistant glass, and leakproof fuel tanks have been provided. The ability of American aircraft to absorb punishment and gunfire has been demonstrated in the "box score" losses in the opposing air forces. Five Axis warplanes to one Allied fighter; seven Jap Zeros to one Flying Fortress and similar scores show a definite superiority of United Nations Air Forces, not all of which can be attributed to superior personnel and tactics.

While the performance with regard to speed, climb, and maneuverability of our aircraft may at times be adversely affected by the installation of armor, the benefits derived from such installations more than balance the drawbacks. Reports of the Army, Navy, and British air forces have shown that American airplanes have been able to return to their bases time and again with bullet-pierced structures and splattered armor plates. When the need for pilots with combat experience is so critical, the price, in weight, paid for their protection is small. When the need for aircraft matériel is so vital, the price paid to keep it in action cannot be quoted in terms of speed and maneuverability.

If a commander has to replace his squadron with equipment and personnel every three weeks, the effect upon morale and organization is detrimental. Not only does he have to secure replacements but he must also start over again a period of training and coordination so that the squadron will fight as a unit. Squadron tactics may be considered one of the essential differences between aerial combat in World War I and World War II. Squadron replacements must be kept to a minimum for both men and equipment to secure a smooth-operating, fighting team and to keep the supply well within the demands. As Kipling so aptly put it: "It is not the individual, nor the army as a whole. But the ever lastin' teamwork of every bloomin' soul." It is the close cooperation and teamwork that have enabled our air forces to outfight the enemy even when outnumbered.

As the protective padding of the football player gives him the assurance to withstand the shock of his opponent and tackle hard, so does the protective armor of the airplane give the pilot assurance to withstand enemy action until he has driven home his own attack.

Relative Vulnerability of Aircraft to Attack

Before considering how the pilot is to be protected, an analysis is presented to determine the relative vulnerability of one airplane to gunfire from another. It is demonstrated that the vulnerability depends upon: (1) The types of gun installations in the opposing airplanes, i.e., whether the guns are fixed or flexibly mounted; (2) The manner of attack, i.e., the relative approach angle between the two airplanes.

Bombers are more vulnerable to gunfire from multiplace fighters than they are to gunfire from single-place pursuits. Single-place pursuits are more vulnerable to gunfire from bombers and multiplace fighters than to gunfire from other single-place pursuits. Similarly, attack airplanes, patrol airplanes, are less vulnerable to pursuit than to other multiplace fighting aircraft.

The opposing types mentioned above shows that they fall into three classes:

(1) An airplane equipped with flexible guns vs. an airplane equipped with fixed guns (bomber or multiplace fighter vs. single-place pursuit).

(2) An airplane equipped with flexible guns vs. an airplane equipped with flexible guns (bomber or multiplace fighter vs. a similar airplane).

(3) An airplane equipped with fixed guns vs. an airplane equipped with fixed guns (single-place pursuit vs. a similar airplane).

The third class may be subjected to the same type of analysis as will be applied to the first class. It therefore will not be considered as a separate case.

Certain factors were neglected in making the analysis in order to simplify the work and graphs. The effect upon the final results is of small consequence. Thus, the acceleration due to gravitational force is neglected in drawing the flight paths. Its effect upon the final shape of the curves would be to either slightly increase or decrease the total resultant acceleration over that shown. The shape and type of curve would remain the same.

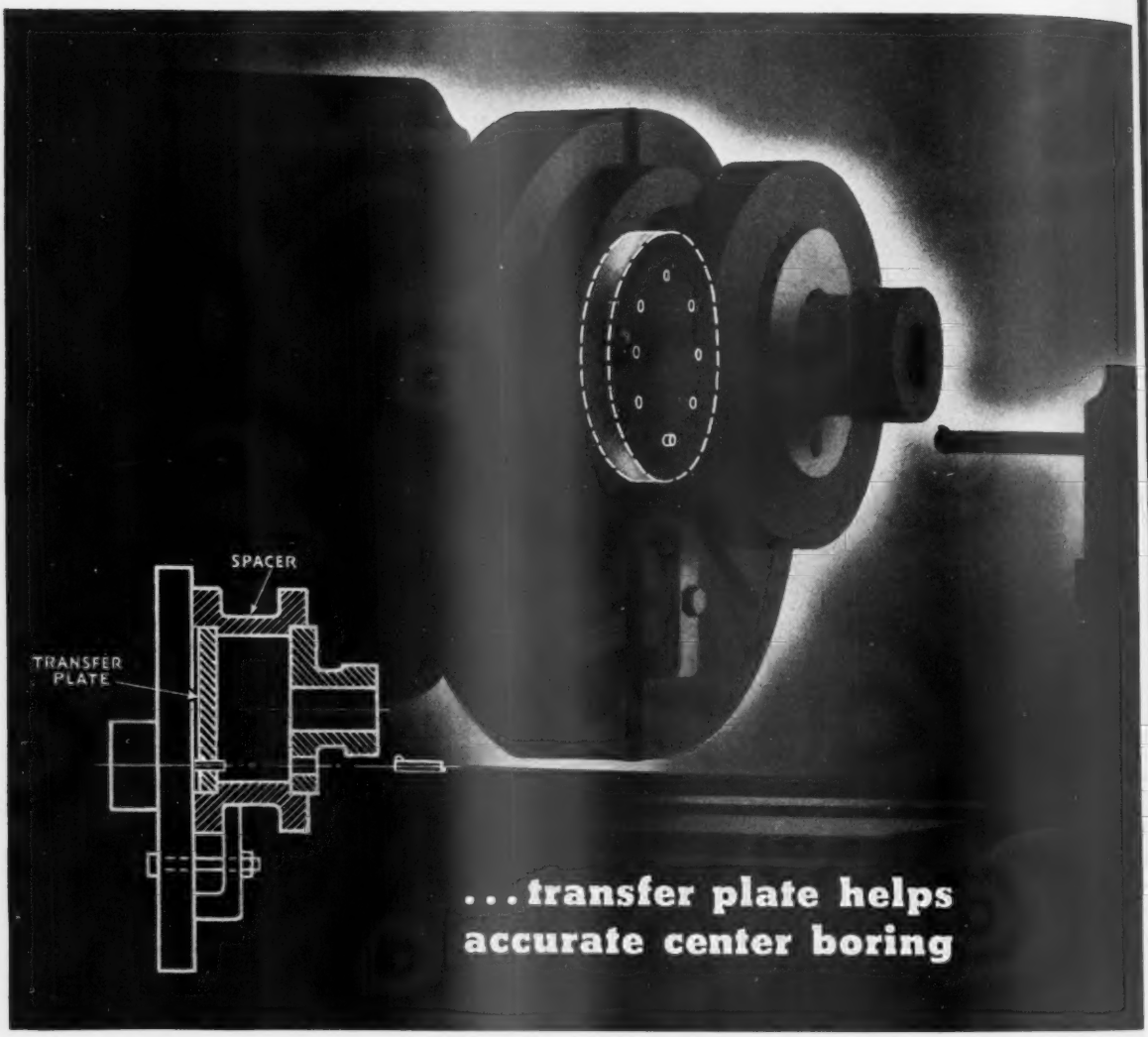
The pilot of a pursuit airplane can perform certain aerobatic maneuvers such as wing-overs, spins, or loops to bring his airplane into an advantageous attack position. Such maneuver is not plotted. However, the conclusions to be drawn from the following analysis are still applicable, since any attempt by the pursuing airplane to hold the attacked airplane in the gunsights will cause the flight path to approach and follow one of those shown in Fig. 1. The pursuing airplane is then subjected to the same restrictions as one that had followed the path throughout.

Bomber vs. Fixed-Gun Single-Place Pursuit

The following analysis is applied to airplanes that fall within Class 1, in this specific example a bomber with flexible guns opposing a single-place pursuit with fixed guns. It is assumed that the speed of the bomber is 310 m.p.h. and that of the pursuit 400 m.p.h., a speed ratio of $V_p/V_b = 1.29$. Additional curves for a speed ratio of 1.03 are shown for comparison. It is also assumed that combat is started at 750 yards. This is very near the maximum range for a 0.50-caliber machine

Presented at the Airplane Design Session, Eleventh Annual Meeting, I.Ae.S., New York, January 25–29, 1943.

* Consulting Engineer.



Information supplied by an Industrial Publication

The problem of drilling a number of holes in a part on precise center distances is seldom simple. It is particularly complicated in mass production of parts where holes must register accurately.

The answer in one plant is what is known as a transfer plate. This is really a circular template, of any thickness over ⅛ inch, with uniform holes drilled on accurate centers. These holes fit a pin located at the exact center of a lathe face plate.

In mounting, the work is assembled to the transfer plate with a spacer between. The assembly is pinned to the face plate through one of the holes in the transfer plate, and clamped tight.

A boring bar in the lathe tool rest can be used to bore a hole of any desired size in the work. The hole will be exactly in line with the pin, and consequently with the hole in the transfer plate.

Subsequent holes are bored by passing the pin through the remaining holes in the plate, until all are bored. When finished, every hole, regardless of diameter should be on the same center as the corresponding hole in the plate.

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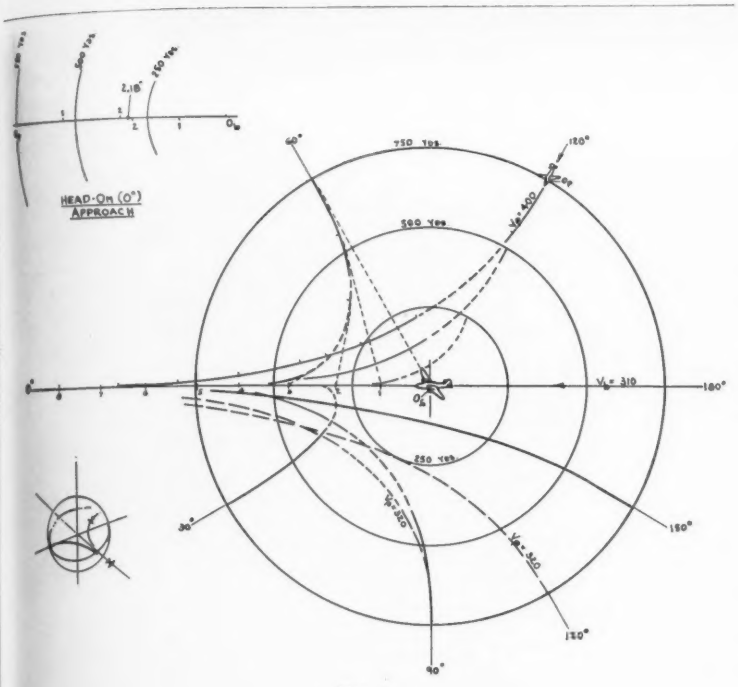


FIG. 1.

gun at which accurate firing and penetration of the projectile through light armor plate may be expected. The drop in bullet trajectory at this range does not increase the total dispersion beyond acceptable limits.

Fig. 1 is a graphic analysis showing the curves or paths of approach of a fixed-gun pursuit when attacking a bomber. The diagram is drawn as a plane figure, but it should be envisioned as spherical instead of a two-dimensional surface. The respective speeds of the airplanes are considered constant throughout the combat. Points O_b and O_p are the origins of the bomber and pursuit, respectively—that is, the bomber is at point O_b when the pursuit is at point O_p. Corresponding positions in space for the two aircraft are indicated at 1-sec. intervals. Around the origin O_b are drawn 250-, 500-, and 750-yard range lines. The horizontal line through the bomber origin represents the flight path of the bomber which is assumed to fly in a straight line. Avoiding action may be taken by the bomber, but the mean flight path will be approximately that shown. The curved paths starting from 30°, 60°, 90°, and 150° represent the paths of approach and attack which it is necessary for the pursuit to follow in order to keep the fixed guns pointed at the bomber when an attack is started from any of these sectors. A series of interesting facts may be noted from these curves.

Combat Time

When a pursuit approaches the bomber head-on from 750 yards at 0°, the actual combat time is a matter of split seconds. In 2.18 sec., the airplanes will meet in collision. An absolutely normal person will have a reaction time of not less than $^1/_{10}$ sec. and not more than $^2/_{10}$ sec. under favorable circumstances. This indicates that the pilot will probably have less than 2 sec. in which to line up the gunsights, fire the guns, and maneuver the airplane out of the path of the on-coming bomber. It is obvious that the effectiveness and accuracy of fire will be hampered by the short combat time. Furthermore, the target area is at a minimum in this type of attack. The period of sustained gunfire is short and combat will very likely be broken off after the airplanes have passed. There will be approximately 26 rounds fired from each 0.50-caliber gun for a 2-sec. burst.

There are certain advantages to the pursuit which occur in this type of attack.

(1) The velocity and therefore the total energy of the projectile is increased, thereby increasing the bullet penetration.

(2) The effective range of the bullet is increased due to the relative velocities of the two airplanes being added to that of the bullet.

(3) The dispersion of the projectiles is decreased because of the reduction in time of flight and distance traveled.

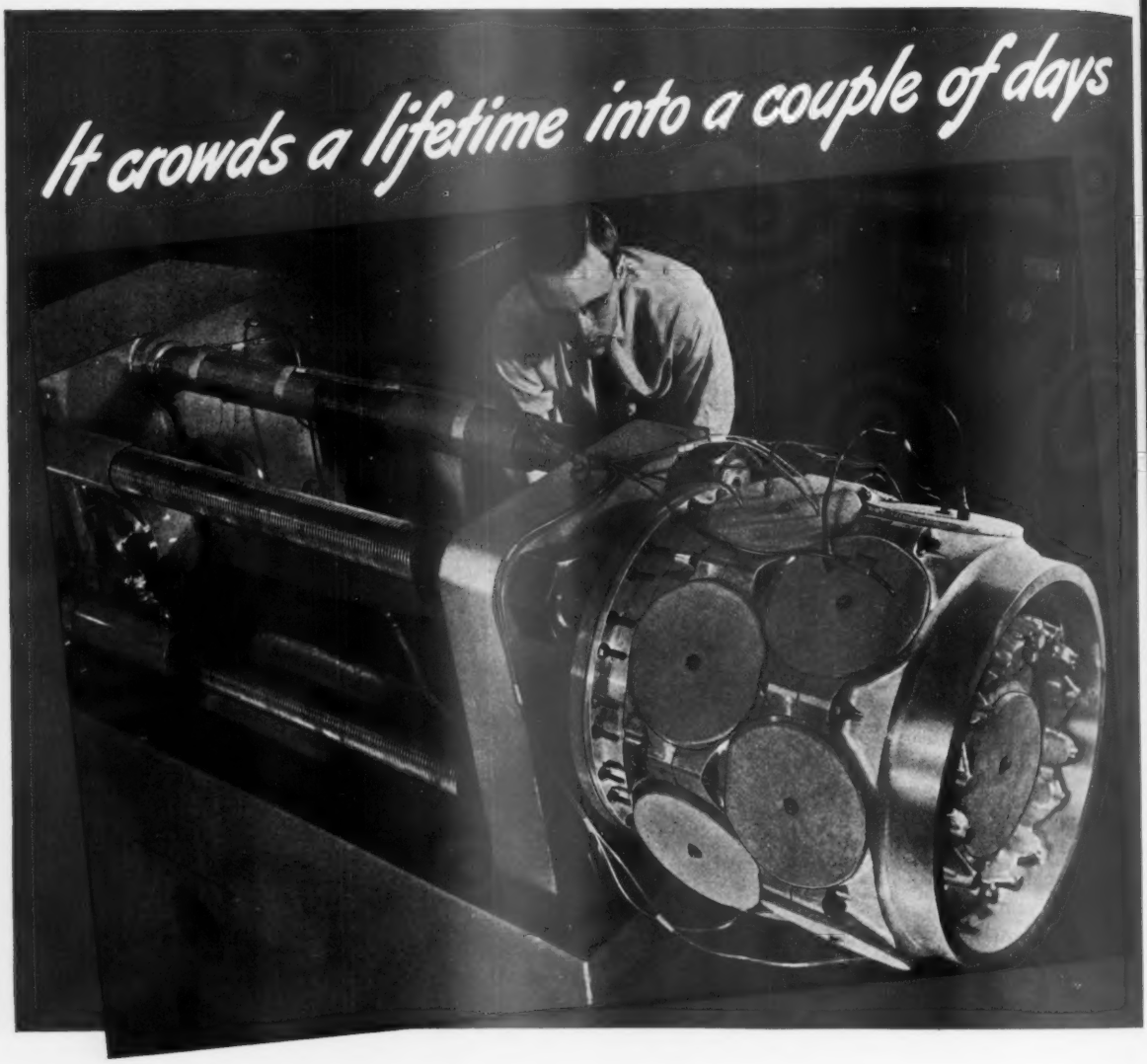
(4) The airplanes close range at a high rate of speed thus reducing the time of flight of the bullet before it strikes the target. The trajectory of the bullet is flatter since the time during which gravity acts on the bullet is correspondingly reduced.

Acceleration Effects

As the angle of approach increases from 10° to 110°, the combat time increases, although not equally for both airplanes. To keep the guns trained on the bomber throughout the combat, the pursuit must have a rate of turn which produces accelerations in excess of $4g$. The dotted portions of the curves shown in Fig. 1 indicate that part of the maneuver during which the radius of turn is less than 2,660 ft. (the radius of turn for 400 m.p.h. and $4g$ acceleration). The sharp radius of turn indicated for the 30° approach angle will produce an acceleration of approximately $39.4g$, while that for the 60° approach is approximately $12.2g$. It is needless to state that the human body cannot withstand such accelerations. It is evident that combat started from the 10° to 110° approach angles will be discontinuous in the case of the pursuit. Throughout such portions of the paths, in which the accelerations exceed $4g$, the pilot will be temporarily blinded and may even lose control of the airplane for periods of 1.50 to 2.30 sec. The gunfire is interrupted and is likely to be ineffective and inaccurate during these periods. These interrupted regions occur at close range to the bomber where the gunfire would normally be most effective. As an axiom to this, it may be stated that combat and gun firing from approach angles of 10° to 110° must be started at long range in the first $1^1/_2$ to 2 sec. of contact in order to be effective.

The relative speed between the airplanes when the pursuit approaches from 60° is 905 ft. per sec. The deflection or lead that must be given to the bullet, because of the speeds of the aircraft, is 410 ft. The spacing between bullets, if the guns are firing at the rate of 800 rounds per min., will be 166 ft. When the vulnerable length of the bomber is 68 ft., it suffices that only two projectiles from any one gun will strike the target for any given sighting of the guns. The bomber, on the other hand, may keep the pursuit in the gunsights and field of fire throughout the entire period of combat. The pursuit may be followed with the flexible guns with increasing accuracy as the range decreases and without cessation of gunfire.

The accelerations will decrease below $4g$ as the paths approach tangency and the pursuit nears the bomber. This again indicates that "a fight to the finish" only seems possible through simple pursuing tactics. It can be realized from the above analysis that the bomber is vulnerable to a limited degree when attacked by a fixed-gun fighter or pursuit from angles of 10° to 110°.



Gone are the days when "running to destruction" meant months of uncertainty. This machine at Alcoa's engine research laboratory determines the facts about a part within a few hours or days! You learn what's what while the design is alive.

On test when this picture was taken was a forged aluminum alloy airplane engine crankcase. Pistons, cylinder heads, connecting rods, bearings, are other typical pieces tested here, under conditions like those encountered in actual service.

Newly designed parts, not yet placed in production, can quickly be tested to destruction. Corrective changes can then be made, if necessary, and the parts retested. Or production procedures can be checked and anything suspicious ruled out. The engine builders learn within a few days how new parts behave.

As a result, our fighting men are getting better, more reliable equipment. And, certainly, the future of your products is being affected by the rapid strides being made here in the design and fabrication of aluminum alloys. ALUMINUM COMPANY OF AMERICA, 1980 Gulf Building, Pittsburgh, Pennsylvania.

ALCOA ALUMINUM

The pursuit, nevertheless, is subjected to fire from the bomber's flexible guns at all times during the combat and with increasing effectiveness and accuracy as the maneuver nears completion.

As the angles of approach for the pursuit increase from 120° to 180°, the period during which accelerations in excess of 4*g* will be experienced decrease, since the paths of approach curve slowly. Also, the time during which combat takes place increases to a maximum and the interrupted portions fade out. Since the paths of approach are flatter, the pursuit may move off the path for a better position without producing excessive accelerations. It therefore retains some maneuverability which introduces the factor of surprise into the combat. The effectiveness and accuracy of the pursuit's gunfire increases, since the rate of change in angle is decreasing and the path is more nearly asymptotic. Slight errors in aiming and changes in airplane angle do not cause the line of fire to deviate by a wide margin as is the case for angles between 60° and 120°. The pursuer therefore benefits by several advantages in attacking from the rear in that: (1) he experiences less physical strain; (2) the duration of the combat is increased; (3) he still retains some maneuverability; (4) the probability of hits increases, since slight errors in aiming do not cause wide deviations from the target; and (5) the relative speeds between airplanes is decreased enabling the pursuer to keep the target in the sights for longer periods.

It can be concluded from the above analysis that the bomber will be subjected to a greater number of attacks and longer periods of sustained gunfire from astern than from any other sector. All attacks by fixed-gun pursuits, regardless of the initial approach angle, tend to converge toward the rear and evolve into a simple pursuing action within a 45° to 57° cone.

Long-Range Air Battles

Formerly, air battles were fought at close range. With the ever increasing speeds of combat, the advantages of being able to fire at long range becomes apparent. Range lines have been drawn in Fig. 1 at 250 and 500 yards to show that if a pursuer opens combat at close range he must turn within a short radius, thereby causing accelerations that exceed 4*g* and materially reduce the chances of effective fire at close range.

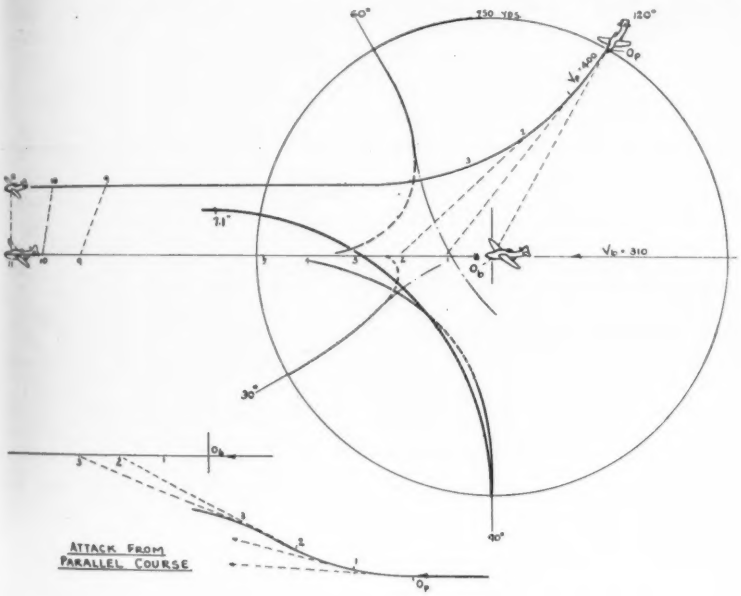


FIG. 2.

It may be safely stated that future combats between pursuit airplanes will be in straight paths and combat will open from greater distances.

BOMBER OR MULTIPLACE FIGHTER VS. FLEXIBLE GUN FIGHTER

The analysis of opposing airplanes which fall within the second class—i.e., an airplane with flexible guns vs. an airplane with flexible guns—is shown in Fig. 2. It is again assumed that the speed ratio is 1.29, the speeds are constant, and the range is 750 yards.

Approach angles from 0° to 90° show little advantage for the flexible-gun fighter over the fixed-gun fighter. It is subjected to the same paths and turn radii as the fixed-gun airplane. Nevertheless, since the pilot does not have to do the gun-firing as in the case of the fixed-gun airplane, better accuracy and more effective gunfire may be expected than for Class 1 airplanes. The advantages of the multiplace, flexible-gun fighter become apparent when the angles of approach increase above 90°. The pilot may either take the same course as the single-place pursuit and bring the airplane into a tail attack or he may swing on a wider radius and bring it into a lateral attack. The path starting from 90°, as shown in Fig. 2, is plotted for a radius producing an acceleration of 4*g* and shows that this acceleration would last for a period of 7.1 sec. Since it is physically impossible to withstand an acceleration of this magnitude for 6 sec. without causing "blacking out," the pilot would be forced to reduce the radius of turn or break off the combat. He may also turn away from the attacked airplane and still maintain combat for a limited time, as shown by the extended paths of the 30° and 60° approaches.

The pilot has more latitude as the approach angles increase and can maneuver the airplane into any position producing the best target for his gunner's fire. In an attack from 120°, he may bring his airplane alongside his opponent in 11 sec. The resulting lateral attack, whether it be above, below, or alongside, will produce the largest target area. The multiplace, flexible-gun fighter may even fly ahead of the attacked airplane and fire to the rearward, an action that is advantageous to the leading airplane. It is thus seen that the flexible-gun fighter has a distinct advantage in that it can pick out any defenseless and vulnerable area and can concentrate its gunfire on that area. There is no portion of the attacked airplane that is immune to the flexible-gun fighter.

A special case is shown in Fig. 2 wherein the pursuing airplane sights an opponent while both are flying a parallel course. Assuming that the pursuer makes a turn that will produce an acceleration of 4*g*, it is seen that for the first 2 sec. of combat the pursuer, if it is a fixed-gun fighter, cannot fire a single shot that will be aimed at the attacked airplane. In the meantime it is being subjected to gunfire itself if the opponent is a flexible-gun fighter. The fighter with the latter type of guns does not have to point the airplane at the opponent; therefore combat can be opened immediately on sighting the target.

These analyses show that, for the fixed-gun pursuit, attacks originating from 75 per cent of the sphere will develop into a pursuing action to the rear of the attacked airplane. Attacks from the remaining 25 per cent of the sphere will be frontal and lateral attacks, which will probably be discontinuous or broken off after a few seconds of combat. At-

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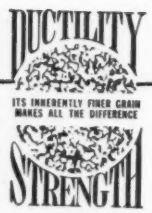

it's the low alloy steel
with exceptional ductility

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tacks for the multiplace, flexible-gun fighter or turreted fighter originating from any portion of the sphere outside of the forward 25 per cent may develop into a pursuing, leading, or lateral attack. It should be noticed that in the majority of actions the initial entry will be made in a pursuing action with the gunfire concentrated at the rear of the attacked airplane.

Vulnerability of Aircraft to Other Arms of Warfare

Airplanes are also vulnerable to gunfire from antiaircraft batteries and to bombing attacks from other aircraft. Such attacks must be avoided by taking advantage of speed, rate of climb, and maneuverability. These would be penalized by an excessive and unwarranted weight increase were protection against a direct hit from the above sources provided.

Protective Armoring

Protective armoring may be divided into three classes: (1) ferrous plate, which is usually face-hardened or homogeneous steel armor plate; (2) nonferrous plate such as aluminum alloys, beryllium, bullet-resistant glass, plywood, plastic, and other composite materials; (3) auxiliary equipment and structure such as leak-proof tanks, tires, wheels, radio equipment, instruments, wing structure, and similar items.

Steel plate is used to protect areas that are likely to be subjected to direct gunfire and to protect personnel. This type of plate is superior to others when the angle at which the bullet strikes the plate is nearly normal. Aluminum alloy plates are superior to steel plates when the angles of obliquity are greater than 45° (the angle of obliquity is defined as the angle between a line normal to the plate and a line through the flight path of the bullet). Light steel plate may be used in some cases by installing the plate at an angle so that it receives a glancing impact instead of a normal blow. Aluminum alloy plate is used for deflector plates and protective covering where the line of impact departs considerably from the normal to the plate. It is lighter than steel for equivalent ballistic properties when used at angles greater than 45°. Composite plates, plywood, plastics, and the like are all used as deflector and baffle plates. In some cases where flowering of metallic structure is likely to cause secondary damage or prevent bullet holes from closing, as in leak-proof tanks, the use of plywood instead of metal as a baffle is recommended. Auxiliary equipment and structure serve as deflector and tumbling plates and are an effective means of decreasing bullet penetration.

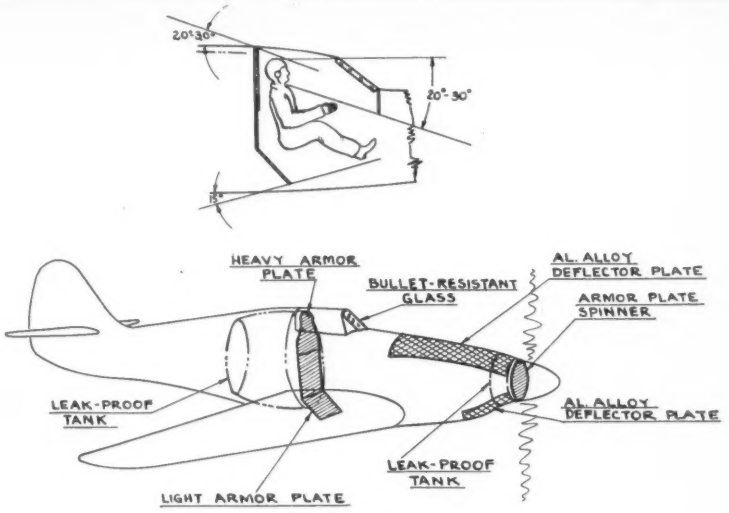

Fig. 3.

Areas Requiring Protection

From the graphic analyses presented in Figs. 1 and 2, the areas that are likely to be subjected to the heaviest gunfire and the location in which protection should be provided for crew members, equipment, and vital parts of the airplane can be determined.

The areas at the tail of the airplane are subjected to a greater percentage of attacks and longer periods of gunfire than areas at the front and sides. The preponderance of armor plate and deflecting shields should provide protection against gunfire from within a 45° to 67° cone to the rear of the airplane. Heavy armor plate should be used up to 30° on either side of the longitudinal axis, since all attacks tend to concentrate at the rear and most sustained gunfire will be directed at the tail. Head-on attacks are extremely limited with regard to area attacked and period of sustained gunfire. However, attacks by multiplace fighters using a leading action—i.e., flying in front of the attacked airplane and shooting back—can occur frequently. It is therefore necessary to provide heavy plate at the front to protect against gunfire from within a 30° cone forward of the airplane. The plate must be heavy enough to take care of the increased velocity of the projectile due to the relative speeds of the airplanes being added to that of the bullet. Protection must also be provided at the side since this area is subjected to oblique gunfire from fixed and flexible-gun fighters during the initial part of the attacks. In the case of an attack by flexible-gun fighters, the side areas may be subjected to sustained fire during a lateral attack. Light-gauge armor plate may be used for protection against direct gunfire and aluminum-alloy plates may be substituted for light skins as deflector plates and shields. Light-gauge plate is possible since the majority of gunfire will be at long range and oblique angles.

Crew Protection

Primary consideration should be given to the crew members when determining the location of armor plate. Personnel located in the nose should be protected against direct fire by heavy plate with lighter wings or side shields to protect against side fire. By putting the plate close to the individual to be protected, the area of plate can be reduced to approximately 8 sq.ft. for full protection. Careful placement of equipment such as the nose wheel, instruments, and auxiliary equipment such as electrical boxes will also serve to protect any member of the crew located forward. The installation of heavy armor plate at the rear of the spinner on a single-place pursuit serves as protection for the engine and pilot at the same time. Bullet-resistant glass in the windshield will protect the face and chest of the pilot. The installation of leak-proof fuel and oil tanks in front or behind the pilot also provides additional protection. The single-seat pursuit is protected against fire from the rear in the same manner as flight crew members on multiplace fighters, with the exception that single-place pursuits must also provide armor plate protection for the pilot's seat and legs, since there is rarely enough protection provided by adjacent equipment as is the case for the larger airplane. Fig. 3 shows the placement of armor for protecting a single-place fighter.

Personnel in the flight station (pilot, co-pilot) and those in compartments adjacent to the flight station require protection against forward gunfire and fire from the rear. Fig. 4 shows the location of armor plate protection on a

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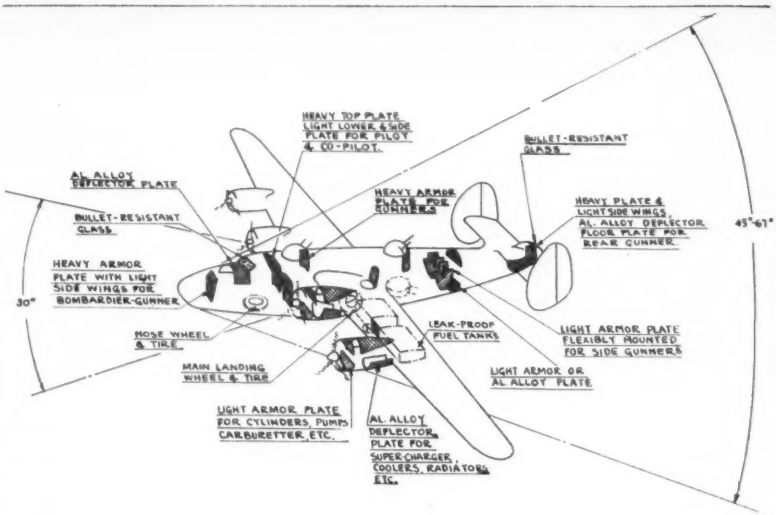
multiplace airplane. Bullet-resistant glass and aluminum-alloy plates may be used to protect the face and upper parts of the body against forward gunfire. Protection against gunfire from the upper sector of the rear cone should be heavy armor plate. The plate should cover the head and shoulders such that protection is provided against any gunfire from within the cone that is defined by a line, drawn from the direction of the attacking gunfire, over the edge of the armor plate and tangent to the body of the crew member to be protected. The upper plate may be welded to a lower plate of lighter gauge which protects the body from the region of the lungs down to the bottom of the seat. Light plate may be used for the lower part, since any bullets striking in this area are likely to have passed through other portions of the structure and lost some of the energy and penetrative power. Protection against gunfire from the lower sector of the cone may be provided by equipment, fuel tanks, wheels, tires, and structure. Heavy aluminum-alloy sheet may be used for skin, at the same time serving as deflector plates for both crew members and vital equipment. The flight station, being adjacent to the engine nacelles, is usually protected against side fire by the wing and engine groups. However, in the single-place pursuit with one engine, side protection must be provided. It is usually sufficient to extend the back plate or place equipment at the sides for protection.

Protection of crew members in the aft portion of the airplane against lateral fire is most valuable in the form of flexibly mounted plates. Side and waist gunners, who are usually the ones to be protected, are likely to need protection in the direction in which they are firing. Flexibly mounted plates require less area to protect than fixed plates because of the fact that the gunners are moving about, thus requiring coverage over large areas if fixed plates are used. Again, good judgment in placing the armor plate will enable the plates to be used for protecting guns, ammunition, and equipment as well as personnel. Side plates for gunners should be of light steel and provide protection from the head to the crotch.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BULLET-RESISTANT GLASS
AL ALLOY DEFLECTOR PLATE
BULLET-RESISTANT GLASS
HEAVY ARMOR PLATE FOR GUNNERS
HEAVY PLATE & LIGHT SIDE WINGS AL. ALLOY DEFLECTOR FLOOR PLATE FOR REAR GUNNER
45°-61°
HEAVY ARMOR PLATE WITH LIGHT SIDE WINGS FOR BOMBARDIER-GUNNER
30°
NOSE WHEEL & TIRE
LEAK-PROOF FUEL TANKS
LIGHT ARMOR PLATE FLEXIBLY MOUNTED FOR SIDE GUNNERS
MAIN LANDING WHEEL & TIRE
LIGHT ARMOR OR AL ALLOY PLATE
LIGHT ARMOR PLATE FOR CYLINDERS, PUMPS CARBURETTER, ETC.
AL ALLOY DEFLECTOR PLATE FOR SUPER-CHARGER, COOLERS, RADIATORS ETC.

FIG. 4.

Splatter shields, in the form of aluminum-alloy angles or splatter preventive coverings, should be attached to all armor plates to keep the shattered bullet from injuring personnel or tearing holes in adjacent structure and equipment. Considerable damage may be done to pipe lines, control cables, and electric wiring by bullet splatter if uncontrolled. Plastic or plywood coverings may be used as an absorbent to prevent dispersion of the bullet fragments.

POWER-PLANT PROTECTION

Air action and losses indicate that power-plant installations constitute one of the chief remaining areas vulnerable to fighter attack. Certain engine accessories such as carburetor, generator, fuel pump, magneto, and supercharger are likely to cause immediate stoppage while radiators, oil coolers, fuel lines, hydraulic lines, and electric wiring constitute a secondary source that may cause engine stoppage after a short time or cause serious difficulty. Protection must be provided for the engines of bombers and multiplace fighters against gunfire from within the 14° to 32° cone to the rear by the installation of light armor plate. It has already been demonstrated in actual combat that considerable protection is given to the vulnerable portions of the engine group by such installations as the landing gear, self-sealing fuel and oil tanks, airplane structure, and air ducts. Vulnerable power-plant components should be positioned so that they are protected by existing aircraft structure and equipment. The discriminating use of deflector plates and heavy-gauge cowling, instead of the lighter gauges now used for covering, will substantially increase the amount of protection given to the engine installation.

Vital equipment such as oxygen bottles, hydraulic accumulators, auxiliary power plants, ammunition containers for cannon shells, and similar material must be either protected by plate or placed in areas that are less vulnerable to gunfire. Areas that are subjected to frontal or lateral attack are suitable locations for such equipment. By concentrating vital mechanisms and personnel in specific areas, they may be protected with fewer pieces of plate.

Again to quote Kipling, who was a witness to many battles: "It is not the guns nor armament, or the funds that they can pay. But the close co-operation that helps them win the day." The close cooperation between aircraft designer and our Air Forces will help in producing better passive defense.

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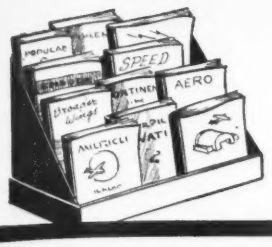

Periodicals

Accessories

Electrics in Aircraft. Lt. Col. Joseph D. Van Sickles. The uses of electricity on aircraft are discussed. The fact is brought out that the Liberator's generators produce enough electricity to supply the average electrical needs of 30 ordinary homes. The use of electricity for aircraft heating, lighting, signaling, and communication is dealt with in separate sections of the article. *Air Tech*, February, 1943, pages 14, 15, 3 illus.

Technical Aspects of Rotameters. William J. Diament. An article on the performance of the Rotameter, a remote-reading fuel-rate metering device, when operating in other than the vertical position. The data obtained and the technique employed in proof of the theory that corrections to non-vertical Rotameter readings can be made by multiplying the indicated reading by the square root of the cosine of the angle of inclination form the basis of this article. An actual correction factor table is included. *Aero Digest*, February, 1943, pages 138, 142, 5 illus.

Lights for Bailed-Out Bales. A description is given of an indicator lamp made almost entirely of plastics which has been developed for attachment to the small parachutes used for the aerial delivery of weapons and military supplies. The lamps are provided with plastic lenses of various colors so that containers delivered at night can be easily identified. It is explained that the light is provided with two standard flashlight lamps operated in parallel from three type "C" dry-cell batteries. *Modern Plastics*, February, 1943, pages 45, 46, 3 illus.

Extintores de a Bordo (Fire Extinguishers Aboard Airplanes). Lorenzo Perez Pardo. A study of fire extinguishers used aboard airplanes. Hand-operated and automatic extinguishers are discussed, as well as their mode of operation. Advantages and disadvantages of the various chemicals used are analyzed. It is shown that after extensive tests the Spanish air force adopted an extinguisher that uses methyl bromide instead of carbon tetrachloride because the extinguishing action of the latter is stated to be rather slow. *Revista de Aeronautica*, October, 1942, pages 287–291, 6 illus.

Aerodynamics

The Influence of Sweep on the Spanwise Lift Distribution of Wings. F. Theilheimer. A method is developed for determining the twist of a swept-back wing with prescribed spanwise lift distribution. Explicit formulas are derived for the case that the lift is given at eight points of the semispan. *Journal of the Aeronautical Sciences*, March, 1943, pages 101–104, 3 illus.

Maneuverability Criteria Through Turning Performance. John E. Goode, Jr. A method has been developed which makes possible the determination of the transition time for an airplane to maneuver into steady turning flight from a level straight-line course and the control deflections necessary to execute this maneuver. Accelerations encountered are easily obtained from data necessary to compute the maneuvering time. The method developed is based on the six fundamental stability equations. The major assumptions are angles of bank and no sideslip during turn. Only the use of conventional wind-tunnel data is necessary.

Calculations are presented for a typical twin-engined attack bomber. The effect of mass distribution is shown by considering a modified single-engined airplane of the same weight and horsepower as that of the twin-engined design. The bank assumption chosen produced a helix angle of 0.090 and maximum bank of 75°. Calculations were carried out for sea level and for 15,000 ft. altitude.

From the standpoint of practical application, the method developed presents not only a means of estimating the maneuvering characteristics of a particular airplane but offers a basis for comparison of similar airplanes, since control deflections necessary to effect a given maneuver are available as a function of time. This is illustrated in the calculations worked out for the two airplanes mentioned above. The time to maneuver from straight and level flight into a steady turn is substantially the same at sea level and 15,000 ft., but at high altitude the control deflections required for the twin-engined airplane exceed those necessary for the modified single-engined one. As suspected, this shows that an increase in spanwise mass distribution is detrimental to the maneuvering characteristics of an airplane. *Journal of the Aero-*

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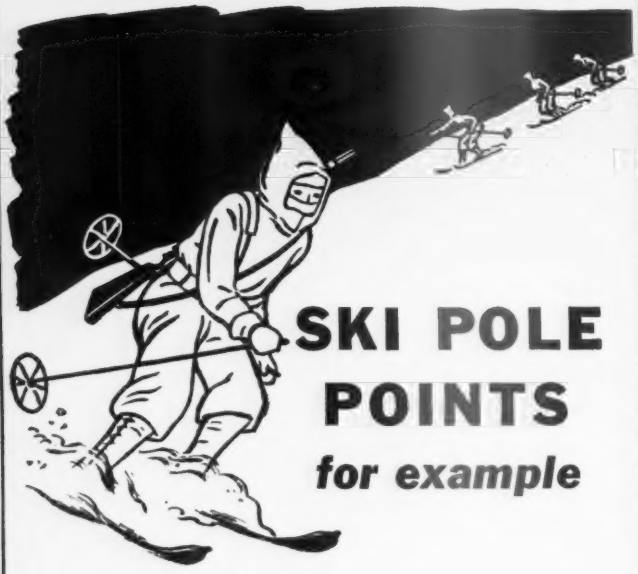

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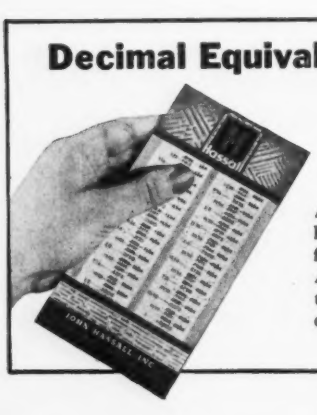

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nautical Sciences, March, 1943, pages 73–80, 6 illus.

How Lift Varies with Speed. Herbert G. Smith. In this second part of an article on aerodynamics the subject of how the lift of an airplane varies with the speed is considered. It is stated that while under certain circumstances the lift may vary directly as the square of the speed, many analyses made with performance data indicate that the law is not literally true. The writer presents the results of analyses made with aid of the performance data of 52 American and foreign monoplanes. The method of approach is statistic. *Aero Digest*, February, 1943, pages 144, 352–355, 1 illus.

The Nose of the Airfoil. Raoul J. Hoffman. Wing design is discussed with particular reference to the effect of variations in the shape of the leading edge on aerodynamic efficiency at different angles of attack. With the aid of cross-sectional diagrams, the writer shows how air flows over wings of different shape and describes the effect of turbulence, the boundary layer, and other factors on wing efficiency. Methods of preventing ice formation by changing the shape of the leading edge of the wing are considered. It is also shown how slots affect the lift and drag coefficients. *Flying*, March, 1943, pages 63, 149, 151, 15 illus.

Air Cargo

Landplanes or Flying Boats for Cargo? Theodore P. Hall. The practical advantages of landplanes and flying boats for cargo purposes are compared, with the conclusion offered that each is expedient for different tasks and that operational circumstances should govern the choice. In a situation where great speed is essential and where suitable airports are available, the writer recommends the landplane. Where high speed is not essential and where there are no suitable airports, he favors the flying boat. Among the factors to be considered in making a choice are economical construction, running expenses, terrain, and weather. *Flying*, March, 1943, pages 20, 21, 124, 5 illus.

Our Present Cargo Plane Situation. Leslie V. Spencer. Reviewing the progress of air transport during the past year and indicating its future trend, the writer comments on some current air-cargo problems. He points out that American experience to date has been solely with converted airliners and that, although these will carry heavy loads, they are not able to transport as much cargo in proportion to their gross weight as will the planes

designed especially for cargo service. A large portion of this article is devoted to quotations from a paper presented at the Air-Cargo Engineering Meeting of the S.A.E. which summarized the problems encountered in cargo handling with converted airplanes and offered suggestions for future equipment.

The article lists some of the converted airplanes that have been recruited for the job of ferrying cargo. Naming the Curtiss Caravan as the one plane designed specifically for cargo purposes on which details have been released, it also mentions the Fairchild military cargo transport. *Aero Digest*, February, 1943, pages 113–116, 351, 352, 9 illus.

Air Cargo Rates May Fall to One-Eighth Their Present Level. Croil Hunter. Postwar air-cargo service is considered with particular attention to transportation cost. It is believed that it may be possible to reduce air-cargo rates from the present 80 to 90 cents per ton-mile to 15 or even 10 cents per ton-mile. With air transport, perishable goods such as fruits and flowers can reach new markets within a few hours after leaving their source. It is stated that Northwest Airlines has conducted experiments on special rates for these commodities which have proved that a profitable volume can be obtained on rates that approach a competitive basis with other means of transportation. The writer feels that the diversion of cargo from other forms of transportation will come gradually and should not be a cause of great concern to surface carriers. He explains that the expansion of air transport creates a large amount of business for railroads. *Air Transportation*, February, 1943, pages 30, 31, 1 illus.

Air Policy

International Air Police Force. "Ajax." Urging that the British formulate an immediate program for united world defense against aggression after the war, the writer recommends a plan for an International Air Police Force. He covers points of organization, personnel, cost, and composition. It is suggested that, centrally directed, this Force should control all civil as well as all military aviation and be supplemented by a small mobile army and navy. For strategic control five main Regional Commands are deemed feasible: a European Command with headquarters in Great Britain; a Pan-American Command with headquarters in America; a Russian Command with headquarters in Russia; an Eastern Command with headquarters in India, China, or Australia; and an African Command with headquarters in the Middle East.

In addition to a discussion of an International Air Force, suggestions are made for World Federations. The British Commonwealth of Nations is indicated as a successful example of a union for common defense. Objections to both an International Police Force and World Federation are refuted, with the International Fighter Command of the R.A.F. offered as proof that loyal cooperation and cohesion are possible among men of various nationalities and tongues when they band together for mutual protection. *Flight*, January 28, 1943, pages 93, 94.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Air Power

The Effect on the War of 1943 Aircraft Production. John A. Ward. This is an analysis of where and how the airplanes that the United Nations expect to produce in 1943 will be used, with particular emphasis upon United States aircraft production. Heavy bombing attacks upon Japan and Germany and the shattering of their air arms are given as the two most likely Allied air objectives for the year. Offensive action on the eastern, western, and southern coasts of Europe and operations against Japan are discussed. The writer indicates the possibility of a campaign to regain Burma and the Malay Peninsula this year, pointing out that the success of such a campaign would relieve the Allies' rubber and tin situation.

Setting United States production of military aircraft at the quoted figure of 90,000 airplanes, the proportions to be sent to Allied nations are approximated. The quality and quantities of planes to be produced, as well as the personnel that will be trained to fly and service them, are compared with those of Axis nations, much to the latter's disadvantage. Marked increases in range, speed, fire power, and bomb loads of aircraft are predicted.

The article also accentuates the importance of heavy bombers in air operations, reviewing their development within the past year. In this connection the removal of objections against high-level daylight raids and the absence of fighter escorts are specified. *Aero Digest*, February, 1943, pages 83–86, 285, 348, 349, 11 illus.

Red Stars over Russia. Major Nathaniel F. Silsbee. This survey of Russian airplanes, tactics, and strategy reflects the ingenuity and initiative that were applied to the development of Soviet air power. General summaries of the type of airplanes used by the Russians are supplemented with brief descriptions of individual planes. Soviet organization, training, pilots, mechanics, and factory production are acclaimed.

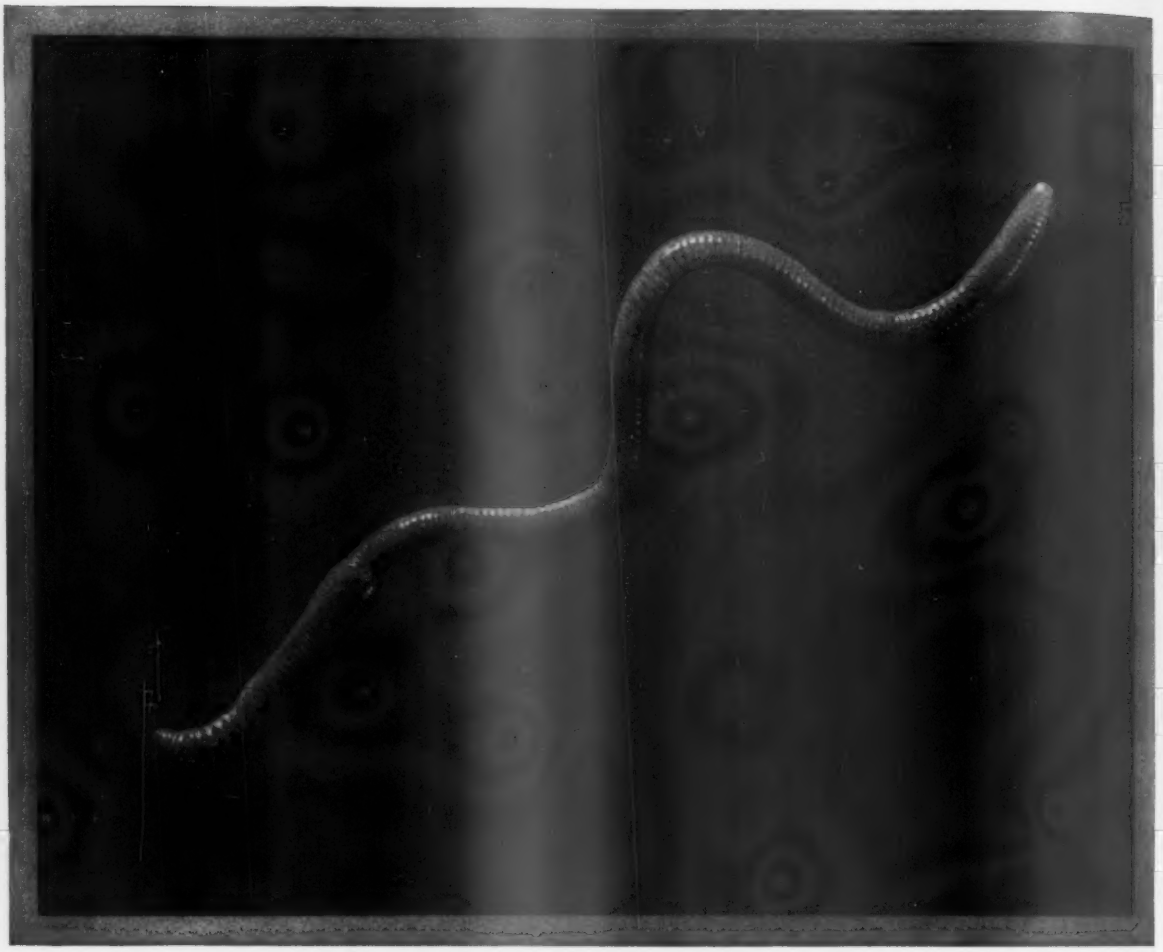
Part of the article is devoted to reviewing the development of the air force. In this the writer quotes different and conflicting authorities on estimates of Russia's air strength during the period of 1935–1937. *Skyways*, March, 1943, pages 20–23, 68, 70, 71, 15 illus.; "Red Comets," James L. H. Peck, *Air News*, January, 1943, pages 24–28, 76, 14 illus.; "Red Air Force," Leonard Engel, *Air Progress*, April, 1943, pages 4–7, 61, 62, 11 illus.

The American Doctrine of Air Power. Part I. Major Nathaniel F. Silsbee. The first of two articles on American theories of air combat states what the underlying principles of American air doctrine are, describes their conception and development, relates the success of their application, and credits the men responsible for them.

Among the general principles that govern the creation and operation of the U.S. air force, four are featured and others are outlined. The four refer to the development of: long-range bombers as the keystone of air power; attack operations, coordinating air and ground forces; fighter operations with special emphasis on interception of enemy planes and air defense; and air transport service that would make the Air Forces self-sustaining. Specifying airplanes and other equipment which exemplify the fruition of these ideals, the article reports on their performance in the Pacific and European theaters of war. It also contains data on the establishment and development of the GHQ Air Force from 1935 to its present form as the Army Air Forces. *Aviation*, February, 1943, pages 112–115, 20 illus.

Air Transport

Around the World in Fifteen Years. The writer tells the story of a flight from Key West to Havana, made 15 years ago, which was the successful



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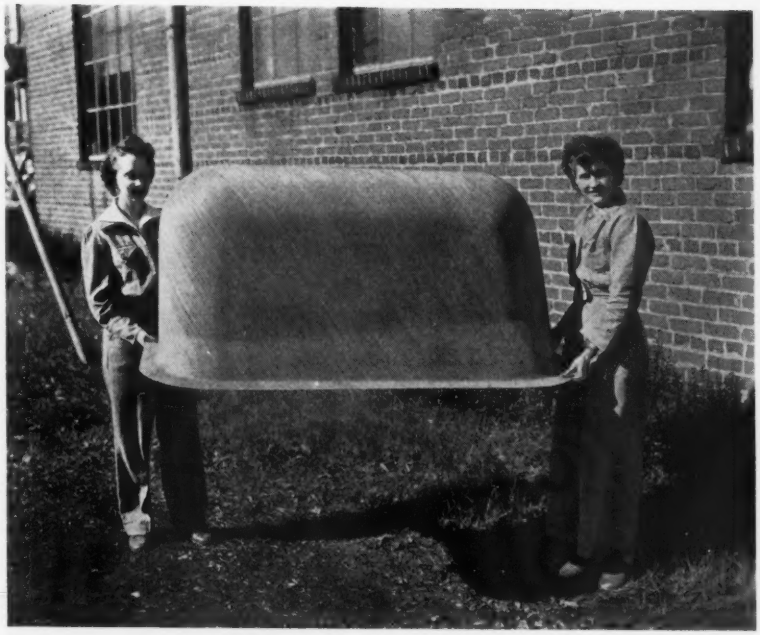
yet inconspicuous beginning of America's first international scheduled airline service. The development of Pan American Airways' international air service is reviewed. *Air News*, January, 1943, pages 30–35, 78, 19 illus.

British Aviation Still Blazing New Trails in the Sky. Joan Bradbrooke. An account of Britain's current problems and future plans in the field of air transport is presented. The writer explains why the general development of Britain's air transport has followed entirely different lines from that of air transport in America. The growth of British air services is traced during the 21 years between the first World War and the present conflict. Brief mention is made of a proposed large transport plane of the future with illustrations. The development of mail carriage by air and of trans-African air transport service is discussed. *Air Transportation*, February, 1943, pages 5–10, 4 illus.

Trooper Into Transport. Capt. Norman Macmillan. The writer investigates the possibility of converting large military aircraft to commercial transport planes for postwar use. He states that the bomber cannot be converted into a satisfactory passenger and cargo plane but finds that the troop transport and supply plane can easily be so converted. It is suggested that this should make it possible to prepare for peace while building for war. Past developments and future possibilities of air transport are discussed. *Aeronautics*, February, 1943, pages 28–31.

Expansion of Post-War Air Transportation. Harry R. Stringer. A discussion of some of the problems influencing the expansion of postwar air transportation, especially with reference to air cargo. Considerations of facilities, types of equipment—large air transports now being built, gliders, helicopters, etc.—operating costs, and traffic control are included. The writer advocates the establishment of definite provisions for shorter hauls and feeder lines and notes the success of the Air Pickup system in this connection. Statistics are included on air transport mileage and tonnage in recent years. *Aero Digest*, February, 1943, pages 95, 96, 296, 299, 300, 302, 303, 4 illus.

Wartime Air Triumph: Double the Cargo With Half the Planes. An article describing the record made in 1942 by United States domestic air lines in the transport of cargo and passengers. It is shown that while the total miles flown declined slightly, total passengers carried climbed 9.5 per cent and express tonnage was more than doubled. The figures given do not cover cargo carried for the armed forces. Sample reports from individual air lines are presented. *Air Transportation*, February, 1943, pages 43, 44.



Durez resin-bonded aerial delivery container as taken from an autoclave at a plant of Aviation Engineering, Inc. (*See* "From the Industry.")

Airplane Descriptions

Assorted Ideas On Light Bombers. Notes and drawings are furnished of some of the less well-known design approaches to the problem of the light bomber. The examples are drawn chiefly from Russian and French sources, the planes mentioned being the Stormovik, the D.B. 3, the P.E. 2, and the Amiot 355. *Aeronautics*, February, 1943, page 33, 5 illus.

Aircraft of the Anglo-American Forces. First part of a review of British and U.S. aircraft in operational service. Specifications and descriptive data accompany illustrations of each plane. With the exception of trainers, the complete operational range—from transport to fighter and heavy bomber—will be covered. Listed alphabetically, this issue shows the: Airacobra, Albacore, Avenger, Baltimore, Beaufighter, Beaufort, Bermuda, Blenheim 1, 1F, and IV, Bombay, Boston III and Havoc II, Buffalo, Catalina III, Chesapeake, Cleveland, Commando, Coronado, and Corsair. *Flight*, January 7, 1943, pages 19–22, 18 illus.

Aircraft of the Anglo-American Forces. Second part of an article surveying British and U.S. aircraft in service. Photographs illustrate the brief data presented on each type. The Dakota, Dauntless, Defiant, Devastator, Fortress II, Fulmar, Sea Gladiator, Goose, and Halifax are dealt with in this installment. Also included are the Hampden, Helldiver, Hudson, Hurricane, and Horsa. *Flight*, January 14, 1943, pages 46–48, 14 illus.

Aircraft of the Anglo-American Forces. This is the third installment of an alphabetical list of some 70 different types of British and American aircraft in operational service. It contains brief descriptions of the Liberator III, Lightning, Lysander II, Manchester, Marauder, Mariner, Mars, Martlet, Maryland, Mitchell, Mohawk, Mustang, Nomad, Roc, Seagull (or Seamew), Sea Ranger, Skua, Spitfire, and Stirling. *Flight*, January 21, 1943, pages 72–75, 19 illus.

Aircraft of the Anglo-American Forces. Fourth part of a compendium of British and American service aircraft. Included in this installment are photographs and descriptions of the Mosquito, Sunderland, Swordfish, Thunderbolt, Tomahawk, Vengeance, Ventura, Vigilant, Warhawk, and Wellington. Also shown are the Whirlwind, Whitley, and Walrus. *Flight*, January 28, 1943, pages 101–103, 13 illus.

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Combat Cousins of the Jap Zero. Some details are given of a Japanese Zero Fighter that was captured in a little-damaged condition after being forced down in Alaska. Specifications of the Mitsubishi 96 and of two American fighters—the C-W 21 and the V-S 143—built four or five years ago, are compared. Comparative data also are presented of the Mitsubishi 96 and the Curtiss Hawk 75 and of the Mitsubishi 97 and the Curtiss 75A. *Air News*, January, 1943, 56, 57, 72, 4 illus.

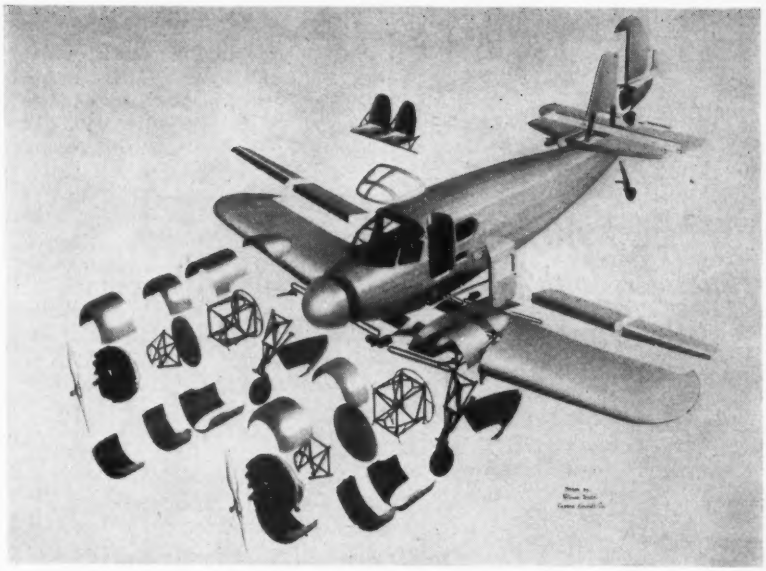
Popular Names for War Planes Made Official. The U.S. Army and Navy have announced jointly that American military airplanes will be known by popular names. Names and official designations accompany illustrations of the 37 principal American planes affected by the change. *Western Flying*, February, 1943, pages 44, 45, 17 illus.; "Nom de Planes," *Skyways*, March, 1943, page 36.

The Stearman in Canada. Details are presented on the Stearman biplane and its performance as an R.A.F. elementary trainer in Canada. Airplane and engine specifications are listed. The writer also makes comparisons between the Stearman and the Tiger Moth, indicating that the two types can be regarded as contemporaries with somewhat different flying characteristics. *Flight*, January 14, 1943, pages 41–43, 4 illus.; "Tough Baby," William D. Strohmeier, *Flying*, March, 1943, pages 48, 143, 144, 1 illus.

Soviet Stormavik. An article describing the Stormavik, a Russian plane that, it is stated, performed so efficiently in attacks against enemy airdromes, troop columns, and supply dumps that the Germans named it "Schwarzer Tod" or "Black Death." It is explained that the plane is designed for extremely low-altitude ground cooperation work and is one of the world's most heavily armed aircraft. It is described as a comparatively large, low-wing, single-seater, full cantilever monoplane, powered with a Mikouline M-38, twelve-cylinder, liquid-cooled engine which provides 1,300 hp. for take-off.

There are drawings showing the plan, elevation, and front view of the plane and cross sections of the fuselage at different points. *Model Airplane News*, March, 1943, pages 20, 21, 52–54, 3 illus.

Two New Japs. Data are presented on two new Japanese airplanes, the 97-2 and the I-45, from information brought to Washington by a member of the American Volunteer Group. Design characteristics of these planes suggest that they may be Japanese versions of German Messerschmitts, modified to use radial air-cooled instead of in-line liquid-cooled engines. The 97-2 is described as a single-engined, single-seater fighter with somewhat greater speed and better diving characteristics than the Zero, indicating a sturdier construction. The twin-engined I-45 is reported to bear considerable resemblance to the Me 110. This plane appeared first as a reconnaissance plane, then as a fighter. It is thought that the I-45 may be equipped with mechanical superchargers of the two-stage blower type. *Flying*, March, 1943, pages 64, 126.



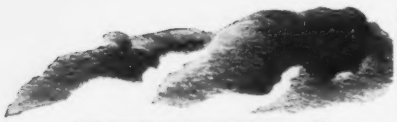
An "exploded" view of the Cessna AT-17 Bobcat with major parts and assemblies in relation to one another.

R.A.F. Fighters. A compendium of Britain's warplanes. Brief descriptions accompany illustrations of each plane. R.A.F. and Fleet Air Arm fighters include the Defiant, Spitfire, Whirlwind, Seafire, Blackburn Roc, Beaufighter, Fairey Fulmar, Hurricane, and Gladiator. The section on bombers contains data on the Beaufort, Skua, Wellesley, Bombay, Envoy, Hurribomber, Blenheim, and Hampden. The Albacore, Lancaster, Swordfish, Stirling, Harrow, Anson, Wellington II, Botha, Halifax, Manchester, Whitley, and Mosquito are also shown. The section called "Flying Boats and Seaplanes" covers the Walrus, Stranraer, Queen Wasp, Lerwick, Shark, and Sunderland. *Skyways*, March, 1943, pages 50–63, 41 illus.

Focke-Wulf 190 A-3. Further data are presented on the FW 190 A-3, considered to be Germany's best fighter. Briefly reviewing the specifications of the plane, this article lays emphasis upon the heavy armament and high rate of climb which characterize it. A weight analysis is made and details are given about the wings. Certain engine installation features are commended. It is estimated that, although the FW 190 is a worthy opponent, it is not a match for the latest types of British fighters. *Flight*, January 28, 1943, pages 99, 100, 6 illus.; "The Focke-Wulf FW 190 A-3," *The Aeroplane*, January 29, 1943, pages 122–124, 3 illus.

Boeing B-17 Flying Fortress. This article briefly describes the latest model in the Flying Fortress series, featuring the improvements it shows over its predecessors. Although the refinements are mostly in internal detail, it appears longer than earlier types and shows an entirely redesigned tail assembly, primarily to give better accommodations for the tail gunner. Figures on bomb loads and range have not been released for publication, but they are stated to be better than preceding models. Speed is given in excess of 300 m.p.h. and ceiling above 35,000 ft. *Aero Digest*, February, 1943, page 155, 2 illus.

The Hawker Typhoon. Some brief details are given about the Hawker Typhoon. Powered by the new Sabre H-type engine, the speed of this single-seater fighter is reported to exceed 400 m.p.h. Carrying heavy armament, the Typhoon is said to differ structurally from the Hurricane and to employ more extensive use of stressed-skin construction. *Flight*, January 28, 1943, page 88.



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Airports

Aeropuertos del Futoro (Airports of the Future). John Walter Wood. Some aspects of airport planning are discussed in an article prepared for circulation in the Spanish-speaking world. The writer describes early types of airports and the method of establishing them and explains how the advent of heavy transport planes, year-round operating schedules, instrument landing procedure, and increased traffic volume have rendered these early landing fields obsolete. Problems connected with the construction of an up-to-date commercial airport are considered. Airports of the present are described as comprising vast tracts of land which must be carefully chosen and expertly designed with due consideration to future traffic expansion. The selection of the airport site and other factors are discussed, including the relation of the airport to transportation systems, the physical surroundings, local atmospheric conditions, topography, orientation with relation to wind, local facilities, and expansion. The concluding section of the article deals with the selection of a site for flying-boat operations. *La Hacienda*, October, 1942, pages 402–406, 6 illus.

Blind Flying

More on Instruments. Robert N. Buck. This is a sequel to a preceding article in which the writer gave advice on the use of instruments in specific flight maneuvers. In this article he explains in detail what to do before and during the take-off, climb, and descent, and when "flying blind." A problem in instrument flying is worked out. Two factors are stressed as particularly important for obtaining the most efficient technique: one is gentleness in applying and releasing pressure; the other, performing as many operations as possible during slack periods in flying so that too many operations do not have to be performed simultaneously at crucial points. *Air Facts*, March, 1943, pages 16–18, 20–22.

Business and Finance

Financial Outlook for the Aviation Industry. H. L. Federman. The writer presents an optimistic view on the market values of aircraft equities for 1943. Explaining why their behavior has not conformed with the industry's production performance, he discusses reasons for an expected rise. One of these is a clear understanding of tax liabilities and the realization that whatever the new tax measures are to be they will not completely con-

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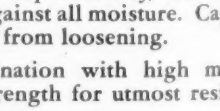

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fiscate aircraft earnings. The other is that, nearing completion, the process of contract renegotiations permits estimates of earnings which indicate favorable reports. *Aviation*, February, 1943, pages 116, 422.

Wartime Air Insurance. Fred C. Crowell, Jr. The Government-directed plan for the insurance of aircraft used in essential war work is explained. To take care of the insurance requirements of both the War Training Service Program and the Civil Air Patrol, every company writing aviation insurance has joined in a super pool and become an insurer under master policies filed in Washington through the three competing pools that have been serving this market for some time. The provisions under which competitors now operate in connection with War Training Service insurance and Civil Air Patrol insurance require that the premiums and losses be equally divided among all the participating companies, with the exception of a certain percentage that goes to the company or group originating the business and is meant to take care of overhead expenses. Required insurance coverages under the War Training Service include personal accident, public liability, and property damage insurance. The Civil Air Patrol requires only public liability and property damage insurance, although accident insurance is available too. The article also advises how to obtain policies under this program. *Flying*, March, 1943, pages 70, 134, 136, 1 illus.

Camouflage

Infra-Red Camouflage. L. E. Bowles. A detailed study of that branch of camouflage engineering which provides against detection by infrared photography. After interpreting the basic principles of infrared reflectivity, the fundamentals of manufacturing coatings that reflect the infrared are explained, and the infrared matching of such coatings with various natural backgrounds are discussed. The article describes how normal things look different when photographed with infrared sensitive film, and the extent to which their colors and backgrounds determine their exposure to this film. It also notes methods of checking the success of this camouflage that is not discernible by the naked eye. *Aero Digest*, February, 1943, pages 159, 160, 162, 292, 295, 6 illus.

Civil Aviation

A Charter for Civil Aviation. F. W. Farey-Jones. The writer remonstrates against Great Britain's laxity in laying the foundations for postwar civil aviation leadership and discusses the lines along which he believes immediate and positive action should be taken. He lists four minimum requirements for a program to assure Britain an ascendant position in air transport after the war: (1) The provision of really modern aircraft, for both passengers and cargo, which will incorporate the technical progress in airplane development made during the war; (2) organizations with a set plan and with a zone in the world's air-line network to organize and prepare, backed by a long-term Government policy, at the outset; (3) personnel for the administration and manning of such organizations; (4) two controlling bodies—a national body dealing with purely British national interests and an International Board of Control for the broader international issues—to regulate their activities.

Among other measures advocated are the establishment of an Air University and the compulsory pooling of all aircraft patents, inventions, and processes. The article also contains the warning that the United States is striding ahead of Great Britain in preparations for meeting the problem of postwar air transport. *The Aeroplane*, January 8, 1943, pages 45–47, 6 illus.

Safety Sleuths. Sanford S. Little. The purposes and activities of the Civil Aeronautics Board's aircraft accident investigators are related, showing how their findings have resulted in regulations or recommendations that have increased the safety of flying. The organization of the Safety Bureau is detailed, its employment of aeronautical specialists noted, and the typical procedure of investigating an accident outlined. Examples are given of the Bureau's thoroughness and some of the safety measures that have resulted from its work. *Flying*, March, 1943, pages 36–38, 72, 4 illus.

Air Traffic to Come. Glen A. Gilbert. A survey of the C.A.A.'s plans for dealing with the problems of postwar air traffic. In addition to an outline of the general control system that is expected to be used, the article touches upon provisions for airport design, instrument landings, automatic systems for handling flight data, segregation of local traffic from the through airway, and an instrument for warning pilots in the air of the proximity of other planes.

It is stated that in all plans for the future, the C.A.A. is moved by two principal considerations: (1) to restrict as little as possible the operation of aircraft under favorable weather conditions; (2) to control aircraft operating in bad weather conditions so that frequency of operation and volume of traffic can approach as closely as possible to that under unrestricted weather conditions. Four rules are listed for the accomplishment of the first goal: Pilots must observe the "rules of the road" when flying along Federal airways; air traffic must be zoned according to type of operation and, perhaps, speed of aircraft; traffic patterns must be established at airports where traffic is light; and traffic towers, with the most modern equipment and methods, must be operated at busy airports. For the accomplishment of the second goal, it is said that automatic flight data communication and posting systems must be installed; airports must be equipped for instrument landing; and automatic separation devices for aircraft must be developed. *Flight*, March, 1943, pages 45, 130, 132, 1 illus.

Design

Problems in Aircraft Structural Research. F. R. Shanley. The more important problems in aircraft structural design and research are presented for the purpose of advancing the knowledge of those engaged in industries that only recently have changed to aircraft work. The objects of aircraft structural research are enumerated and structural research problems are classified. A few points regarding external loads are discussed. Problems of flutter and compressibility are outlined. The writer then takes up the subject of internal loads. The stresses on shell-type beams, which are widely used in airplanes, are considered. Other sections of the article deal with cutouts in shell structures, buckling, instability, the combined loads in aircraft structures, joints and fittings, structural indexes, and materials for aircraft structures. *Mechanical Engineering*, March, 1943, pages 169–178, 13 illus.

Designing for Production. James E. Thompson. Part I of an article on production design fundamentals and procedures. The basic factors governing production design are listed as: (1) simplification of design; (2) practicability of assemblies and installations; (3) elimination of close limits and clearances; (4) use of existing parts

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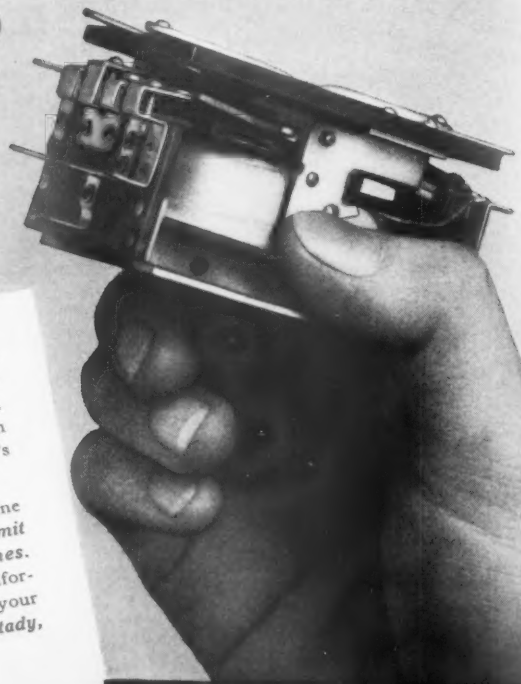

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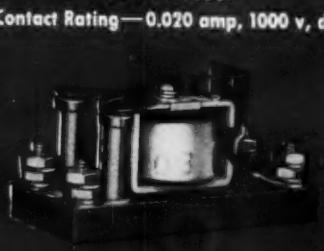

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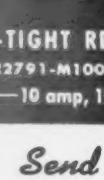

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CR2791-J102B
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and standards; (5) use of readily available materials and tools; (6) serviceability. This installment is concerned with the first two points. It explains why and how design should begin with the most simple arrangement that will fulfill basic functional requirements and then be elaborated only enough to become a practical production design. Practicability of assemblies, unit subassemblies, and bench assemblies are treated in detail. *Western Flying*, February, 1943, pages 58, 60, 62, 64, 94, 6 illus.

Wing Tips.....Round versus Square. W. E. Hick. A semitechnical discussion of the advantages of round versus square wing tips is presented. The aerodynamic efficiency of both types is discussed under sections covering the trailing vortices, induced drag, weight, and the effect on performance. *Aeronautics*, February, 1943, pages 42–45, 8 illus.

Modern French Designs. Recent developments in the field of original French designs are given. Covering both civil and military types, these developments are credited to orders placed by the Vichy Government with the consent of the Nazis. Data are submitted on the Dewoitine D 520 single-seater fighter, the Loire-Nieuport LN 40 dive bomber, the Bloch 157 single-seater fighter, the Latécoére 298 torpedo bomber, the VG 50 twin-engined aircraft, and the Bloch 162 four-engined bomber. Progress is recorded in the development of prewar prototypes of civil aircraft models, with notations on individual planes. An experimental type of rotating wing aircraft and the construction of flying boats are referred to. *Flight*, January 7, 1943, pages 10, 11, 12, 6 illus.

Lofting Problems of Streamline Bodies. Part 10. Carter M. Hartley and Roy A. Liming. The tenth of this series of articles on lofting problems deals with the tangent line method of constructing a parabolic curve, its application to a duct elbow fairing development, the development of a wing fillet, and the development of a second-degree curve to enlarged or reduced scale. *Aero Digest*, February, 1943, pages 130, 132, 134, 136, 10 illus.

The Case of the "Unconventional" Lightplane. C. Alvin Moeller, II. The views of the writer are presented on the design trend involving so-called unconventional types of light aircraft. It is assumed that the airplane is intended for general private flying, for which reason it is shown that among other compromises involved in all well-balanced design two major considerations are essential. These are elimination of the loss-of-control type of accident and adverse aileron yaw. Landing gears and different types of ailerons are described as well as the performance obtained with them and the technique of taking off and landing. The characteristics of the tricycle landing gear and the two-control system are emphasized. In conclusion it is stated that the present two-control airplane offers many desirable features while suffering few disadvantages. The performance of a recent prototype is detailed and it is predicted that this type of aircraft will be considered as the "conventional" type. *Air Facts*, March, 1943, pages 60–66, 2 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

You Thought It Was New! David C. Cooke. To prove that military aviation today is not a departure from but a refinement of military aviation of the first World War, examples are presented to show that many modern "innovations" are merely adaptations of old developments. Among the features investigated are: tricycle landing gear, all-metal construction, concealed engine, retractable wheels, wing flaps, armor plate, and the flying wing. Airplanes that incorporated these and other features prior to 1919 are mentioned. *Air Progress*, April, 1943, pages 20–23, 62, 8 illus.

Sound Design, Accuracy Save Payload. E. J. Foley. Weight control in the design and operation of transport planes and its effect on the payload are reviewed. Design discrepancies for which the manufacturer is responsible are discussed. Inconsistencies due to a lack of functional concept in engineering aircraft are pointed out. Consideration is given to the air transport operator's goal, which is stated to be the maintenance of the maximum practical useful load of aircraft; the perpetuation of the manufacturer's detail of weight control through the operator's parallel organization; and the studied elimination of all weight discrepancies (whether manufacturer's or operator's) which may defeat the purpose of the weight-control program. *American Aviation*, March 1, 1943, page 42, 1 illus.

Production Control of Design Changes. James D. Robbins. This article deals with the necessary paper work that must be done when changes in design are made. A system is offered which is said to reduce the chances of error, minimize the amount of paper work, and combine in one form the necessary items of information. This master form follows the entire design change procedure from the beginning to the end of its departmental cycle. The explanation of how it fits into the entire system is illustrated by an accompanying table. *Aero Digest*, February, 1943, pages 215, 216, 271, 4 illus.

Davis Wing Patent Studied. S. R. Winters. The features of the "clipped" flying wing patented by David R. Davis are described and illustrated by a diagrammatic drawing. This invention provides for a smaller flying wing and places the engine and the useful load within the wing-foil structure. It is claimed that any weakness caused by poor aerodynamic action at the wing has been remedied by curving the wing's front edges slightly forward as they approach the tips and by rounding the tips. *Western Flying*, February, 1943, pages 74, 78, 1 illus.

Fighter Design. Five representative fighter types are examined to show the extent to which individuality of designers influences airplane design. On the premise that aerodynamic design is necessarily less flexible the writer limits his analysis to structural characteristics. He compares the advantages of girder and stressed-skin methods of construction and differentiates between single-spar, two-spar, and multispar type wings. The fighters studied are the Spitfire, Hurricane, Mustang, FW 190, and Airacobra. *Flight*, January 28, 1943, pages 89–92, 10 illus.

The Hurricane. Frank Spencer Spriggs. The evolution of the Hurricane's design and its development in the past ten years are reviewed. Emphasizing the versatility of this plane, some of its features are the Hurricane's armor protection, long range, and latest adaptation to high-speed bombing. *Flying*, March, 1943, pages 28, 29, 120, 122, 7 illus.

Airplane Design for Cargo Transport. Carlos Wood. Factors involved in the design of airplanes for cargo transportation are analyzed and discussed at length, with the conclusions of the analysis summarized to indicate the trends future design should follow. Investigating bases of economical operation for cargo airplanes, the writer offers a formula for determining the cargo utility of an airplane. He lists the basic factors to be considered in cargo plane design as weight, drag, span, power, stalling

FLOATS FOR OUR SEAPLANES... *For many years Edo has occupied a position of world leadership in the development and manufacture of float gear for seaplanes. As a consequence of specialization, Edo has long since become the recognized supplier of single and twin floats to virtually every American aircraft manufacturer . . . The war found Edo engineers and production methods ready and the transition to large scale production of float gear for our military aircraft was swift and smooth. With the aid of greatly increased facilities, exacting schedules have been met fully and on time. The Army-Navy "E," flying over the Edo plants, is an assurance that all is well on this sector of the vast production front.*

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speed, and handling time and examines the effect of each of these items separately. In addition, the relative importance of certain combinations is observed.

Tracing future design trends, it is stated that the following are evident both from a military and a commercial standpoint: (1) Since operation at higher altitude is apparently a coming factor, circular-section fuselages may be expected; (2) the cargo compartment will have a flat floor and resemble a freight car in general dimensions; (3) the use of airplanes for mixed cargo and passenger loads will call for a re-examination of airplane arrangement for more versatile use; and (4) every attempt will be made to reduce the distance from the ground to the cargo compartment. Many other points are discussed, including engines and terminal facilities. A series of charts supplements the text of the article. *Aero Digest*, February, 1943, pages 185, 186, 189, 190, 249, 250, 21 illus.; "Transportation in the Post-War Period," A. N. Kemp, *Aviation*, February, 1943, pages 118, 119, 417, 418, 421, 422, 1 illus.

Engines

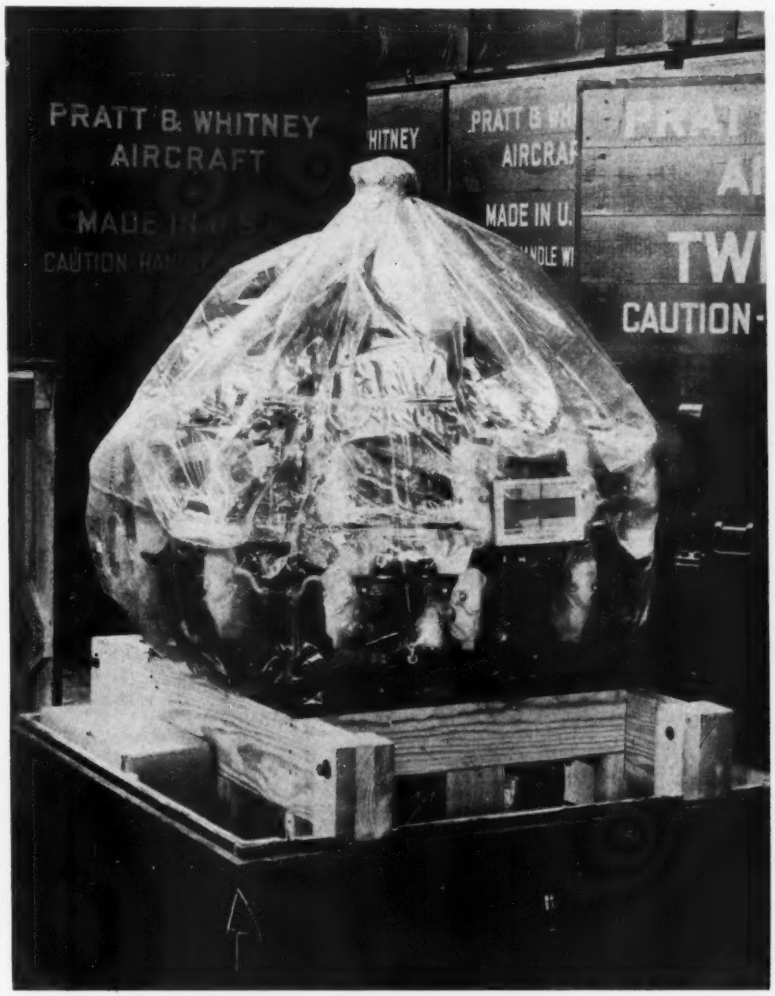
Instrumentation in the Study of Diesel Combustion. E. W. Landen and L. A. Blanc. The writers describe the physical apparatus and technique that have been developed for the study of fundamental processes of combustion within the cylinders of Diesel engines. It is stated that the study of engine performance actually should begin with an investigation of the energy changes taking place in the combustible material. Information on the "window technique" developed for the optical study of combustion which makes possible spectrographic and other means of flame observation is given. The writer describes the study of combustion and its effects on the cylinder by means of the Edgerton camera and also the technique of measuring pressures within the combustion chambers with the cathode-ray oscilloscope. It is noted that the records of flame duration and pressure obtained are of most immediate interest to the engineer. *Transactions of the A.S.M.E.*, February, 1943, pages 121–125, 11 illus.

The Case for Fuel Injection. Peter Franklin. The advantages to be derived from fuel-injection systems are explained. The good results Germans are obtaining with inferior gasoline are credited to a special system of spraying atomized fuel into their engines. Comparisons are made between fuel injection and carburetion to show that more power is obtained from engines with the former method. However, it is stated, the complexity of fuel-injection systems may make their installation undesirable at times. *Air Progress*, April 1943, pages 46, 76, 1 illus.

Petrol Injection System of a German Aero-Engine. Details of the direct fuel-injection system used on the B.M.W. 801 air-cooled radial engine of the Focke-Wulf 190 are given. The general layout of the fuel supply system is described and illustrated diagrammatically. Information is given on the design and operation of the centrifugal-type deaerator, pendulum-type deaerator, fuel-injection pump, injection nozzle, and automatic mixture control unit. *The Engineer*, February 5, 1943, pages 109–111, 3 illus.

Gipsy's 1,260 Hours. A report on the condition of the various parts of the Gipsy Major I engine after a test run of 1,260 hours. The general condition of the engine was so satisfactory that it necessitated but a negligible amount of replacement parts and occasioned the overhaul period for this engine to be advanced officially from 1,000 to 1,260 hours. *Flight*, January 14, 1943, pages 44, 45, 4 illus.

A Brief Survey of the Principles of Pressure Water Cooling. James E. Ellor. The writer investigates the problems involved in reducing the total drag of aircraft and at the same time keeping the rate of heat dissipation per unit of frontal area of radiator as high as possible. Certain disadvantages of the usual method of increasing the temperature difference between the cooling medium and the coolant by the employment of ethylene glycol as a coolant are discussed.



A Pratt & Whitney engine packed ready for shipment. Note the moisture indicator within the sealed transparent bag.

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Nellie has been nicked. Some of the enemy fighters she met will never fly again . . . but that last one got in a burst that drilled a dozen holes in Nellie's fuel tanks. Now, high over hostile territory, and hundreds of miles from base, she's heading home.

Make it? Sure she will. Nellie's fuel is carried in self-sealing tanks, made possible by Hycar gasoline-resistant synthetic rubber. Almost instantly those bullet holes closed, sealing in the precious fuel that will keep her flying. Hycar is "seeing Nellie home".

The selection of Hycar for this critical application where so much is dependent upon so little, where even partial failure cannot be tolerated, was based solely upon its performance record. Whatever *you* need in a flexible or resilient material, the ingenuity and years of pioneer development work behind Hycar will give to you the same kind of safe, trouble-free, dependable service.

And whether the prime requirement is excellent resistance to oil or abrasion, hardness or softness, good electrical properties or operation over a wide range of temperatures, each type of Hycar is a known quantity. In hose, vibration dampeners, hydraulic seals, packing, pistons and hundreds of other uses, Hycar has been proved by field experience.

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A sealed pressure water system for making use of the physical characteristics of the increase in boiling temperature with pressure, which is stated not to possess the disadvantages of the glycol system, is described. Design details of a header tank and a suitable thermostatic header tank relief valve for this system are presented. *S.A.E. Journal*, March, 1943, pages 65–68, 77, 5 illus.

Engine Development. The progress made in aircraft engines during the past few years is briefly outlined. Outstanding developments are stated to be the steady increase in power and rated altitude and the adoption of complete "power eggs" to speed production. A comparison is presented between three successive fighters produced during the last war and the Me 109E and Spitfire of the present war. *Aircraft*, January, 1943, page 22.

Air Filters for Airplane-Engine Protection. William K. Gregory. The importance of employing air filters to protect aircraft-engine parts from wear is emphasized. The selection of the proper type of air filter is considered. Research conducted on viscous impingement-type air filters is described, and problems connected with the selection of materials for air filters are discussed. The procedure followed in determining the proper size of air filter for an engine is briefly outlined. *The Draftsman*, February, 1943, pages 33, 45.

Corrosion of Bearing Alloys. L. M. Tichvinsky. This paper describes laboratory experiments conducted to determine the corrosion resistance of various engine bearing alloys when tested with straight, with additive-type and re-refined lubricating oils at elevated temperatures. Some of the experimental engines were operated with crankcase oil temperatures over 280°F. and with bearing temperatures far in excess of 300°F. The results of the experiments are given, with numerous charts and tables. *S.A.E. Journal*, March, 1943, pages 69–76, 12 illus.

Flight Technique

The Elevator Doesn't Elevate. Wolfgang Langewiesche. An analysis of the action of an airplane's controls, with instruction as to their proper manipulation. The hazards of pulling back on the stick under certain conditions are discussed, and the writer indicates the relation of this operation to stalls and spins. He also discusses the trend of incorporating the restriction of controls in the mechanical construction of an airplane. *Air Facts*, March, 1943, pages 49–58.

It Takes Sense to Fly! John R. Hoyt. The writer lists what he calls "five senses" that are necessary for good piloting. Explaining their relationship to flight technique, he elaborates on flying by sight, by feeling, by hearing, and by the "seat of the pants." The fifth sense, common sense, he claims can be gained by constant self-analyzation and learning from experience. *Flying*, March, 1943, pages 57, 58, 128, 129, 1 illus.

How's Your Coordination? William D. Strohmeier. The writer analyzes the importance of perfect coordination to the correct method of making flying turns. He admonishes the pilot to make certain that he is not holding rudder in turns but that stick and rudder pressures are applied and relaxed at exactly the same time. Dangers from poor coordination are pointed out, the variance of the importance of coordination in different types of flying is discussed, and different methods of developing coordination are indicated. However, the writer also gives reasons why he believes the importance of this characteristic will diminish after the war. *The Sportsman Pilot*, February, 1943, pages 10, 11, 42, 3 illus.

Fuels

No Fuel Like Our New Fuel! Lorania K. Francis. The development of 100-octane fuel is traced, its properties are defined, and information on the processes of manufacture is given. The four basic components used in the manufacture of this fuel are set forth as base stock, high-octane blending agent, light blending agent, and tetraethyl lead fluid, and each of these components, as well as the procedures by which they are prepared, is described. Comparisons are made of the sources of supplies of high-grade fuels in the United States, in other Allied countries, and in enemy countries. *Skyways*, March, 1943, pages 38, 39, 94, 4 illus.

History

Conquest of the Air. A compilation of notes on the development of aviation. The events listed cover a period as far back as 1472 and as late as 1930. Later notes pertain mainly to the progress of aviation in the military services of the United States. *Air News*, February, 1943, pages 15–19, 31 illus.

Prophecy in Retrospect. Capt. Holden C. Richardson. An article on Alphonse Penaud, nineteenth century French aviation pioneer, and his patent for a plane which is claimed to have fathered the modern "flying wing." A detailed description of the plane shows that it incorporated many of the principles and methods now exploited for high-performance design. Its inclusion of a tail is one way this model differed from today's "flying wing," but it is stated that the tail design is the one still used on all but the tailless types of planes. Foreshadowing some of the most modern developments in aircraft, Penaud's patent provided for a high-wing, twin-tractor monoplane amphibian with retractable four-wheeled chassis, streamlined body, and vertical fin with balanced rudder at the rear.

The article also contains information on other aerodynamic and aeronautical experiments made by Penaud. *Southern Flight*, February, 1943, pages 28, 29, 39, 40, 44, 49, 6 illus.

Instruments

Graphical Analysis of Delay of Response in Air-Speed Indicators. Kalman J. De Juhasz. The delay of response of the pneumatic system of the air-speed indicator is analyzed by a graphic method and illustrated by an example of an actual installation, with various simplifying assumptions and for various modifications of the system. The results are compared with those previously obtained by mathematical analysis. The results of mathematical analysis agree well with those obtained by graphic analysis for those pneumatic systems in which the inertia of the moving air column is small in comparison with the resistance to flow; in other cases important deviations have been found. The design data for minimum delay have been determined. Applicability of the method for any given law of impressed pressure change is illustrated by examples. *Journal of the Aeronautical Sciences*, March, 1943, pages 91–97, 10 illus.

Jet Propulsion

Wire-Tailed "Snare" Rockets. Photographs are presented of wire-tailed rockets used by British merchant ships to prevent German dive bombing and machine-gun attacks. A brief description of the rockets, based on a study of the photographs, is given. It is stated that the rocket charge appears to be black powder. The launching device is a simple metal tube set up on legs. Two metal rods attached to the side of the rocket are hooked onto a fitting connected with one end of a roll of wire in a container. The rocket charge appears to be ignited by means of a small alcohol burner. *Astronautics*, February, 1943, pages 8, 9, 3 illus.

Valier Motor. Early rocket motor experiments conducted by Max Valier in Germany are reviewed. An automobile he designed and demonstrated, operated by a rocket motor, is described and illustrated. Valier was killed while making preparations for another demonstration of this car. It is explained that the motor was evidently of regenerative design. *Astronautics*, February, 1943, page 10, 2 illus.

Semi-Rocket Airfoil. Charles T. Piecewicz and Gustav A. Kindsvogel. Reference is made to the Caproni-Campini thermal-air-jet-propelled airplane in which the designer used the fuselage as the main component for the thermal air stream. The writers extend this principle to include the airfoil of a plane. They describe a semirocket airfoil based on the Venturi principle intended to eliminate the use of a turbine. The flow of air is explained with the aid of a diagram. *Astronautics*, February, 1943, pages 12, 13, 1 illus.

Completing the carcass of the new Goodyear military-airplane tire which uses thousands of small spiral metal rings to increase the tread's effectiveness in preventing skidding on snow and ice. (*See* "From the Industry.")

Landing Gear

New Technique Saves Material in Producing Tapered Landing Gear Tubing. J. P. Dods. Methods by which the Summerill Tubing Company are able to save material and speed up production of tapered landing-gear tubing are related. By effecting changes in design, expensive inside boring is eliminated and the tubes are machined from the outside. This technique, in addition to being less costly than the inner method, is claimed to be more accurate. Changes in the process of drawing the part through a die, which reduces the amount of scrap material necessitated, are also depicted. *Aero Digest*, February, 1943, pages 149, 150, 348, 6 illus.

Non-Rubber Resilient Wheels. A brief description is given of a system of resilient metal wheels recently constructed and submitted to the British Government, which is said to have possibilities for application to aircraft landing wheels as a substitute for rubber tires. Helical springs are used instead of solid spokes. By means of overlapping discs and protruding pins, provision is made for taking the lateral thrust and for limiting the strain of the springs to a predetermined value. *Aeronautics*, February, 1943, page 46, 3 illus.

Liberator's Landing Gear. Edward Churchill. Constructional features and operational considerations of the Consolidated Liberator's landing gear are presented. It is explained that this landing gear is hydraulic in principle and application. Sections of the article discuss landing-gear operation, hydraulic applications, the nose wheel, and the tail bumper. *Air Tech*, February, 1943, pages 20, 21, 4 illus.

Lighter-Than-Air

Helium For Hitler. Lt. Fred Tupper, Jr. Interpreting the convoy and patrol function of blimps, this article acclaims the record of their antisubmarine activities. The training and duties of blimp personnel are also noted. *Air News*, February, 1943, pages 48, 49, 62, 7 illus.

Maintenance

Make That Airplane Last. J. H. Dressel. Maintenance hints are given for prolonging the usefulness of private airplanes and keeping their requirements for replacement parts and materials to a minimum. The following parts are among those for whose longevity suggestions are made: various engine components, propellers, metal cowlings, batteries, tires and landing gear, control systems, fabric coverings, and pyralin windshields and windows. *Air Progress*, April, 1943, pages 34, 64, 65, 4 illus.

Unified Powerplant Design to Benefit Airlines. E. J. Foley. In this article the writer describes the trouble experienced by air transport operators due to incidents of conflict between the aircraft manufacturer and the engine manufacturer regarding design deficiencies. As a solution to the difficulty, he suggests better cooperation and that increased responsibility for the entire power plant and its accessories be assumed by the engine manufacturer. *American Aviation*, February 15, 1943, page 36, 1 illus.

Maintenance Cooperation. Robert J. Curry. This discussion of the maintenance problems connected with the operation of flying services is concerned with the importance of having the planes properly inspected and in perfect condition at all times. The point is emphasized that perfect maintenance is of vital importance to mechanic, pilot, and operator and requires the cooperation of all three. *Flying*, March, 1943, pages 105, 106, 142, 1 illus.

Management

Air-line Engineering Management. Ivor Lusty. Part VI of a series of articles on the engineering management of air lines gives further consideration to the engineering management department. Inefficiencies caused by the necessity of rendering service under conditions of peak load are discussed, and it is advised that the work be arranged so that as little as possible is done by the inefficient sections. It is suggested that improvements in reliability resulting from better design and maintenance methods may make it possible to dispense with maintenance personnel entirely at stations having no scheduled overnight stops. Problems connected with the operation of large stations where overnight stops are the rule are considered. *Aircraft Engineering*, January, 1943, pages 19, 20, 1 illus.

Pied Piper of the Pacific

Getting rid of rats takes on a new distinction as the rest of the world moves to overpower Axis treachery. And nowhere is a better job being done of it than by the gallant members of the U. S. Army Air Forces. For heroism in the southwest Pacific this announcement of the award of the Silver Star to Lt. Clifton H. Troxell comes from General MacArthur's Headquarters, Australia, October 16th:

...alia. ... attended ... School and Case School ... Science, was cited for gallantry over New Guinea.

Piloting an Airacobra fighter, he downed one Jap Zero and scattered others which attacked transports he was escorting. After breaking up the numerically superior enemy formation he continued his patrol.

With the devastating fire power of his cannon bearing P-39 Airacobra, this modern Pied Piper of the air destroys the rats which threatened to overrun civilization.

When the rats are gone, he'll come back to a world in which the technical advances that war has brought to Aviation will be put to even greater use. We, at Bell Aircraft, will have the engineering ability, the means of production and —most important—the tradition of Aviation pioneering to play our part in that coming era. © Bell Aircraft Corporation, Buffalo, New York.

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A cutaway perspective drawing of the new Curtiss 12-foot wind tunnel. Motors of 12,000 h. p. will drive propellers nearly 22 feet in diameter to force air at high velocity through a testing "throat" where instruments will record the flying characteristics of large-scale test models.

● Hurricane? No hurricane of record even could approach the 700-mile-an-hour man-made tempest which will be turned on and off at will in the new Curtiss wind tunnel. One of the world's two largest, it is but part of the modern equipment in the new Curtiss Research Laboratory where all of the complex phases of tomorrow's aviation will be explored.

Here is impressive evidence that the aviation industry is looking ahead to the skies of the future—to a not far-distant day when giant passenger liners ... huge cargo carriers ... luxurious private craft ... fighters, bombers, battleships of the air ... will fly at altitudes and speeds eclipsing anything that the world knows today.

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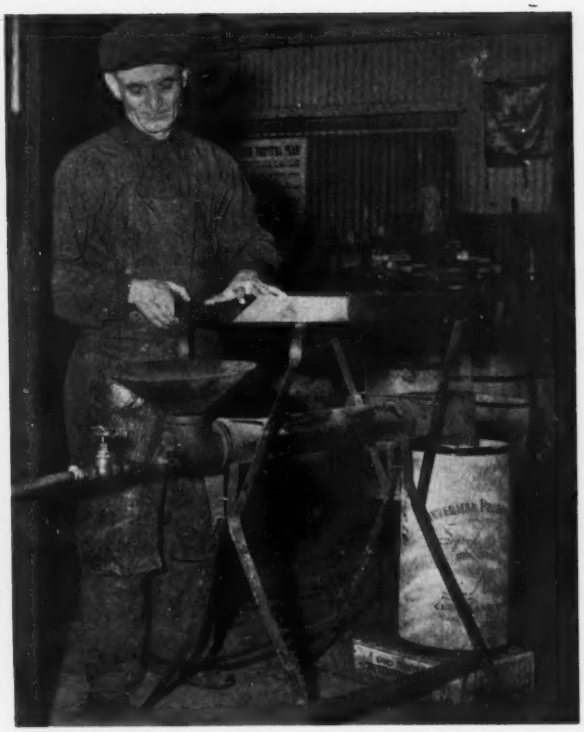

(*Left*) With the aid of a jet of compressed air, the strips of packing paper are separated from strips of stainless steel used in the manufacture of self-locking speed nuts. The paper is threaded into the gun and falls into the waste basket.
(*Right*) A compressed air gun shoots lacquered lock nuts against the wire screen and breaks them apart. (*See* "From the Industry.")

Manufacturing Equipment

Infra-Red Radiation. Theoretic and practical aspects of the employment of infrared rays for such operations as paint drying and shrink fitting are presented, and basic principles of the process are described. The writer then tells how the nature of the work surface affects the rate of heating. Following a discussion of the use of infrared rays for paint drying, other applications of the process include the softening of plastics to render them suitable for molding and punching and the shrink fitting of aircraft-engine parts. Other sections of the article deal with parabolic reflectors, trough reflectors, plant design, engineering principles, installation design, trough equipment, and automatic switching. *Aircraft Production*, February, 1943, pages 83–87, 9 illus.

Materials

Wood—the Most Important Raw Material of the Future. Nelson C. Brown. The importance of wood in industry is emphasized and its future applications are discussed. It is stated that wood is likely to be more important to civilization than many other industrial materials because it has such universal application and use, is abundantly available in a variety of textures, is relatively inexpensive, and is replaceable. The writer mentions an improved form of forestry which should enable the United States to grow all the wood for its needs and perhaps also carry on a substantial export trade. He describes how war needs have widened the field of wood application. The number of types of American airplanes which are being built of plywood is given. It is also noted that several European airplanes are largely built of birch plywood. The need for further research to increase the knowledge of wood properties is stressed. Figures on the past production and use of wood in the United States are given and future developments are discussed. *Mechanical Engineering*, March, 1943, pages 182, 196.

Some Mechanical Properties of Plastics and Metals Under Sustained Vibrations. B. J. Lazan. An evaluation of the damping capacity and dynamic modulus of rigidity of both plastics and metals was accomplished with the use of a new oscillatory-type testing machine developed for determining the mechanical properties of materials under alternating torsional strains. Studies were made to show how the damping capacity and dynamic modulus of rigidity are affected by sustained cyclic stress below the endurance limit and also at impending fatigue failure. With a similar dynamic testing machine built for applying alternate direct stress, parallel studies were made under axial loading conditions. To supplement the dynamic tests, the mechanical properties of selected materials in static tension, compression, and torsion were also determined. The wide deviations observed between the static and dynamic moduli of elasticity for plastics are analyzed and are associated with the damping capacity of the material. The significance of these deviations, as related to the repeated constant-deflection type of fatigue test on plastics, is discussed. Experimental data on the damping capacities, dynamic moduli of elasticity, and some static mechanical properties are presented for mild steel, Duralumin, grade X laminated Bakelite, laminated-canvas phenolic, and methylmethacrylate plastic. *Transactions of the A.S.M.E.*, February, 1943, pages 87–104, 19 illus.

Rubber. V. L. Gruberg. This article discusses the United Nations' problem of obtaining sufficient rubber

for their war needs and offers a study of the methods by which this problem is being solved. Certifying the importance of rubber to air power, it indicates the extent of present natural resources and tells how synthetic rubbers are being developed to supplement them. Characteristics of natural, synthetic, and regenerated varieties of rubber are examined.

Synthetic rubbers are summarized as being derived from three main sources: (1) directly from minerals (petroleum or coal); (2) from foodstuffs or potential foodstuffs (grain, maize, potatoes, and starch-containing products generally); and (3) from acetylene (indirect mineral source—coke and lime). With their outstanding qualities described as oil resistance, resistance to heat, resistance to deterioration by exposure to light or oxygen, and resistance to gas diffusion, they are classified into several groups. These consist of: the Neoprene group, Buna-S, Buna-N, and Butyl; Thiokol, Koroseal, and Vistanex.

Specific efforts of different countries in the development of rubber are noted. The countries include the United States, Great Britain, Russia, and Germany. *Flight*, January 7, 1943, pages 13–18, 13 illus.

Spars by Radio. George R. Reiss. A detailed description is given of a high-frequency process for laminating wooden spars. Within a short time internal heat dries glue evenly and firmly, leaving the natural moisture of the wood almost completely undisturbed. How the light-plane industry utilizes these wooden spars is explained. *Flying*, March, 1943, pages 33, 34, 147, 4 illus.

Auto Body Steel in Aircraft. Fabrication details are presented on a new Vultee aircraft development that makes possible the substitution of automobile-body type steel for aluminum in aircraft construction. Vultee's solution to the problem of effectively increasing the thickness of thin steel sheets without any substantial increase in weight is a method of spot welding expanded metal mesh to the sheets. Giving the advantages of this type of steel, the article also explains the possibilities in variety of applications offered by this new material. *Flying*, March, 1943, pages 91, 92, 3 illus.

The Effect of Wood Structure Upon Heat Conductivity. F. F. Wangaard. A study of the effect of fibrillar orientation upon the heat-conducting properties of wood indicates a new technique for the selection of various qualities of this material. It is shown that the differential thermal conductivity of wood in the longitudinal and transverse directions is chiefly due to the anisotropic character of the fibrils, and deviations from anticipated transverse-conductivity values, as well as longitudinal-transverse heat-conductivity ratios, are closely related to fibrillar orientation. The application of longitudinal-transverse conductivity ratios is proposed particularly for the detection of mild compression wood. *Transactions of the A.S.M.E.*, February, 1943, pages 127–135, 7 illus.

Medicine

Medical Problems in the RCAF. Group Capt. J. W. Tice. Specialized problems of the Royal Canadian Air Force Medical Branch are presented in a paper read before the Aero Medical Association of the United States. The selection of aircraft personnel is discussed. The writer describes changes in methods found necessary to meet the large training program with which the R.C.A.F. was faced in 1939. Sections of the article cover physical problems, nutrition, and industrial hygiene. It is suggested that the role of the air force medical

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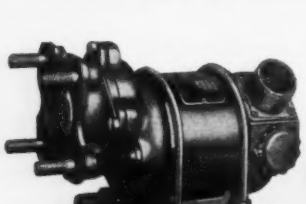

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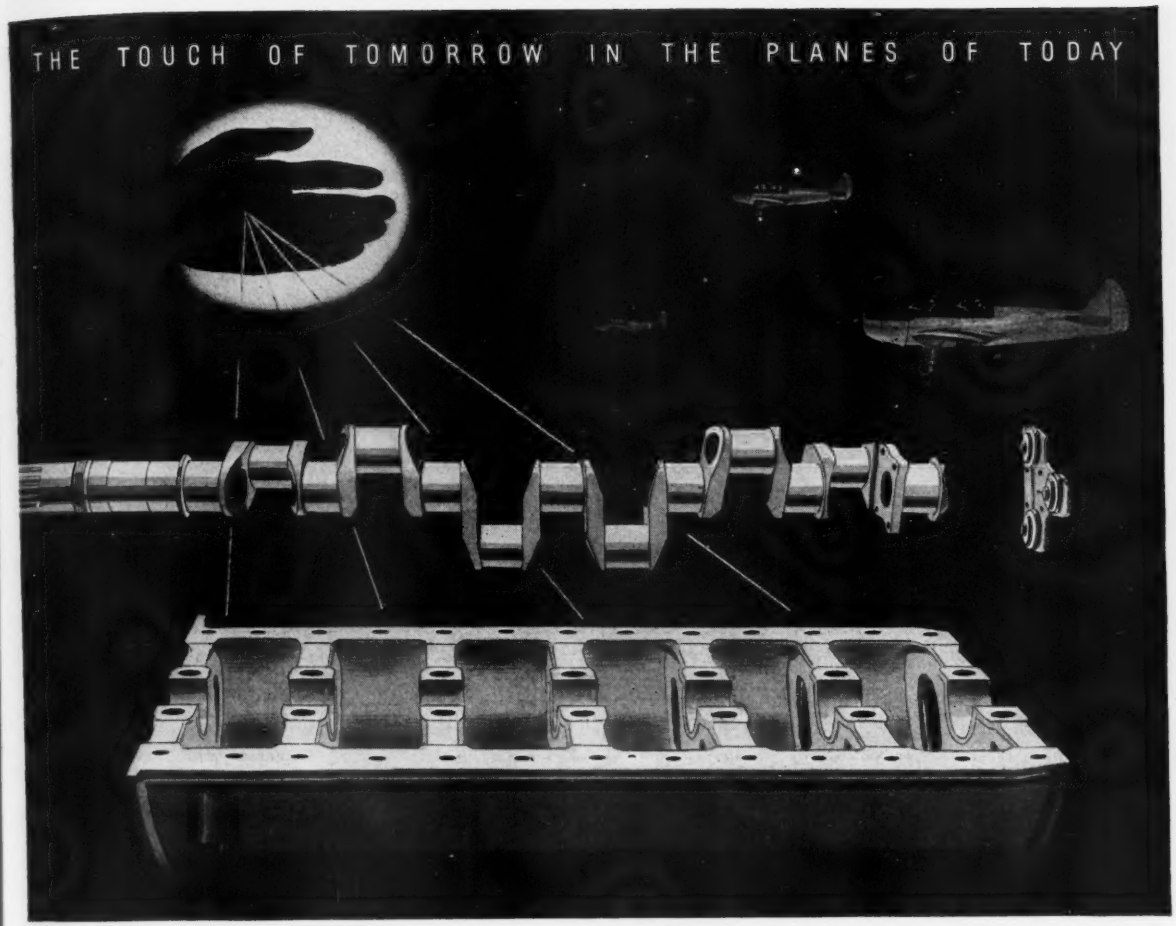

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officer lies in the field of preventive medicine as well as military medicine. *The Journal of Aviation Medicine*, February, 1943, pages 4–9.

What it Takes to Make a Good War Pilot. Medical problems connected with the selection of those pilots who will make good in war are discussed in the first installment of a series of articles. Problems connected with high-altitude operations are considered. It is explained that there is a misconception that body tissues will expand under reduced atmospheric pressure because of the decrease in pressure on the body surface and also that the internal pressure of blood vessels will be higher because of the decrease in counter-pressure from without. These conclusions are not justified, it is stated, because the tissues contain more than 70 per cent water and the remaining substances, like a fluid, cannot be markedly compressed even by a pressure of several atmospheres.

Reference is made to the distress caused by expansion of gas or air in closed body cavities. The effect of changes in altitude on the nasal sinuses and the middle ear are discussed. Information on altitude sickness, or anoxemia, which is stated to be caused by the fall in oxygen content and therefore of oxygen partial pressure in the inhaled air to a value inadequate to supply the oxygen requirements of the body, is given. *Aircraft*, January, 1943, pages 16–18, 2 illus.

Development of All-Purpose Single Aperture Goggles. Comdr. Leon D. Carson. Defects of standard types of aviation goggles are enumerated. Details of a single aperture goggle designed by the writer and developed with the assistance of the Polaroid Corporation are given. The design embodies a lightweight molded contour-fit goggle frame made entirely of soft sponge rubber and provided with a clear, nonshatterable optical plastic lens. The lens is set in a single wide aperture with no nasal or center division. Research work resulting in the development of a satisfactory dark adapter lens is described. *The Journal of Aviation Medicine*, February, 1943, pages 10–14, 3 illus.

Night Blindness. J. Barnett. Pointing out the importance of night flying in time of war, the writer explains that the night flier's main equipment is his capacity to see in the dark. He describes how night blindness is detected and discusses its cause, which, it is explained, is due to lack of visual purple in the retina of the eye. Experiments are described which have shown that vitamin A deficiency is a cause of night blindness. *Aeronautics*, February, 1943, pages 75, 76.

Boeing Aircraft Photograph from the Office of War Information
The latest type of Boeing Flying Fortress.

Effects of Total Ventilation by Obstructing Blood Vessels and by Muscular Effort. Capt. José Raúl Delucchi. This paper covers a study of the variations of total pulmonary ventilation caused by partial vascular obstruction of both legs because of the pressure of tight boots over the calves, by the muscular effort of one leg pushing the airplane rudder constantly, and by both obstruction and muscular effort together. The experiments were carried out in the Fatigue Laboratory of Harvard University. It is concluded that wearing tight boots is undesirable because they increase the ventilation rapidly when work is done with the legs. It was found that a constant push of 30 lbs. on an airplane rudder during 5 min. with or without vascular obstruction of both calves produces discomfort and fatigue. *The Journal of Aviation Medicine*, February, 1943, pages 23–27, 1 illus.

Accidentes de Aviacion, lo que Puede y Debe Hacer el Medico (Airplane Accidents which Should be of Interest to Physicians). Evelio de Elizalde Lainez. Airplane accidents are classified as having been caused by the following factors: (a) pilot, (b) airplane, and (c) flight. It is stated that the majority of accidents may be traced to a deficiency or a disturbance of the physical and mental qualities of the pilot. According to accident statistics, the pilot may have been tired and exhausted, imprudent, or overconfident, or his training may have been incomplete. Accidents due to the airplane itself are ascribed to deficiencies of the prototype, deficiencies of construction, aerodynamic deficiencies, or deficiencies in repair and maintenance of the aircraft. Accidents due to flight conditions are charged to altitude, speed, variation of attitude, acceleration, or combat.

Summarizing his investigations, the writer recommends: (1) scrupulous physical and psychologic tests of the flying personnel; (2) periodical fitness tests; (3) elimination of those who definitely have lost flying aptitude; (4) elimination of those who are physically abnormal; (5) keeping the flying personnel in perfect psychologic and physical condition; (6) investigation of the effect of the problems arising from the action of atmospheric agents: speed, diving, acceleration, etc., on the pilot. *Revista de Aeronautica*, October, 1942, pages 273–276.

Military Aviation

Air-Borne Division. R. Montgomery. A report made by the writer following a visit to an air-borne division of the British Army. It indicates the progress that has been made by the British Army toward universal air-mindedness and a full appreciation of what can be done with air-borne troops. *Aeronautics*, February, 1943, pages 48, 49, 2 illus.

"Squirts" of the RAF. This article describes the diversified duties of an R.A.F. group captain. Under his control are the squadrons with their flying personnel; the operations staff; the administration of the station; the airfield defense; air-raid precau-

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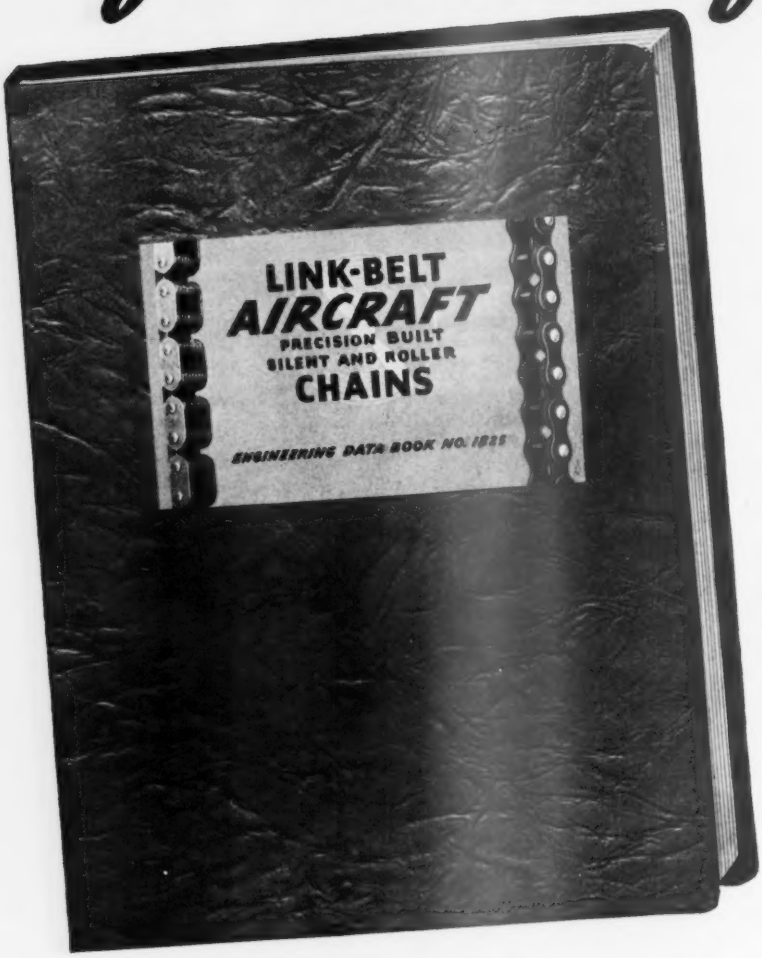

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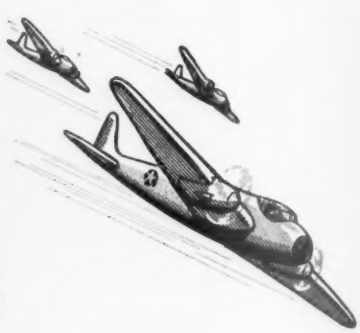

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tions; and the normal branches of R.A.F. operation which include Intelligence, Signals, Medical, Religion, Transport, Clerical, Catering, Engineering, and Armament. To illustrate some of the problems with which he must deal, a group captain's schedule for an average day is outlined. *Air Progress*, April, 1943, pages 26, 72, 73, 1 illus.

Aeronáutica Militar—Cooperación con el Ejército de Tierra (Military Aeronautics—Cooperation with the Ground Troops). Lt. Col. Martínez Merino. In this article it is emphasized that the part of Douhet's theory which considers aviation as an auxiliary of the ground forces has been repudiated by the present war. According to evidence presented, military aviation is able to perform independently missions that never could be carried out by the army or the navy alone. The statement is made that on November 9, 1939, Spain created an independent air force to cooperate with the army and the navy. Based on experiences of the Spanish Civil War and the present war, the writer gives an outline of the organization of this air force, such as command, squadrons and their strategic utilization, military staff of the cooperation units, and the territorial distribution of the squadrons in time of peace. *Revista de Aeronautica*, October, 1942, pages 243–248, 1 illus.

Fighters Unmasked. Robert McLarren. Reference to the controversy over the respective merits of various military aircraft is made. It is stated that there is a real need for a method of evaluating aircraft which will afford an insight into the tactical value of the various types. The writer suggests a method of rating which he believes will give some conception of the respective merits of pursuit planes. *Model Airplane News*, March, 1943, pages 6, 7, 56, 58, 59, 8 illus.

Gliding Into Battle. Capt. R. G. Collins. The writer reviews briefly the various uses to which air-borne forces have already been put and speculates on future methods of employing them. The advantages and limitations of both gliders and parachutes for landing troops for battle are discussed. *Aeronautics*, February, 1943, pages 50, 51.

Naval Aviation

Carriers Should Be Expendable. Part 2. Cy Caldwell. Advocating large task forces of light aircraft carriers, the writer tells how such carriers could be used in new combat tactics. Touching upon the operational difference of land- and carrier-based planes, battleships and carriers, and small and large carriers, he cites the advantages of a small, inexpensive, expendable carrier and suggests strategies for which it could be used. *Air Progress*, April, 1943, pages 14–17, 74, 75, 4 illus.

The Vega PV-1 naval version of the Ventura bomber. This land-based patrol plane is powered by two 2,000-hp. Pratt & Whitney engines. (*See* "From the Industry.")

Steady Growth of U.S. Navy Air Power. A historic outline is presented of the development of naval aviation in the United States. *National Aeronautics*, February, 1943, pages 14, 15, 32, 6 illus.

How Naval Battles Are Fought. The writer reviews important naval engagements of this war, describing the strategy and tactics used. While the article deals mainly with fleet actions, there are frequent references to the air angles of naval warfare. In discussing attempts to clarify naval strategy, the writer warns against the formulation of hard and fast rules on how the various types of war machinery—air, undersea, and surface—work together under battle conditions, pointing out that so far no two sea engagements of this war have been the same. There is a reference made to the success of the Japanese in sinking the battleship "*Prince of Wales*" and cruiser "*Repulse*" with land-based planes and to an attempt, made later, to sink an American battleship off Guadalcanal with a heavy air assault which failed. *Scientific American*, March, 1943, pages 100–103, 137, 2 illus.

Personalities

Navigating Professor. Kurt Rand. An article on Charles Zweng and his Pan-American College of Celestial Air Navigation. Supplementing biographic details on Zweng, information on the school's course of training and the achievements of its graduates is given. *Flying*, March, 1943, pages 59, 77–80, 2 illus.

Young Man of the Year. A brief review of the events in the business career of George J. Newman. It is told how he progressed as workman, pilot, and executive to the position of vice-president of Consolidated Aircraft Corporation at the age of 34. *Southern Flight*, February, 1943, pages 42, 43, 5 illus.

Roundell, R. N. Charles Kennett. A character sketch of Comdr. Richard Henry Roundell of the British Fleet Air Arm. Captain of the torpedoed "H.M.S. *Courageous*" among other ships, the highlights of his naval and aeronautical career are related briefly. *Air Progress*, April, 1943, pages 38, 71, 72, 2 illus.

Leaders of the Luftwaffe—XVIII. H. J. A. W. The careers and characters of Max Ibel, Colonel, Commanding Fighter Groups of the 3rd Air Fleet, and of Joachim Coeler, General der Flieger, Commander of the 9th Flieger Division, are described in this installment of a continued article on German air leaders. Germany's secret rearmament activities after the first World War helped to prepare

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And your men
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What a break
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With a
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What a break
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both these men for the positions they occupy in the second war. Ibel is a veteran of the German Army, Coeler, of the Germany Navy; Ibel is concerned primarily with fighter groups; Coeler, with bombers. The former is described as a trained and efficient airman and a stern disciplinarian. Of Coeler, it is stated that he is a worthy commander, and ruthlessness rather than genius characterizes his methods. Both men support the Nazi party insofar as it is responsible for the restoration of militarism to Germany. *The Aeroplane*, January 8, 1943, page 39, 2 illus.

Leaders of the Luftwaffe—XIX. H. J. A. W. A brief biography and character sketch of Adolf Galland, Inspector of Fighter Pilots and the youngest of Germany's major-generals. Decorated and promoted for his exploits as a fighter pilot, this 30-year old general is described as the first pilot entrusted with high command while still young. Ranking as Germany's leading ace, he has devoted his life to flying to the exclusion of everything else. Galland is a product of the secret and intensive training given to German youngsters after the first World War. Although he has no interest in politics, it is thought that he would remain loyal to the Nazi Party. In combat, it is said, he fights methodically and scientifically, with coolness and deliberation. *The Aeroplane*, January 15, 1943, page 72, 1 illus.

Leaders of the Luftwaffe—XX. H. J. A. W. This chapter of a continued article on the officers of the German Air Force is devoted to Hauptman Werner Baumbach, noted bomber pilot and youngest Wing Commander of the Luftwaffe. Still in his twenties, bred in the Nazi philosophy, and trained from early childhood for war, Baumbach ranks as one of Germany's most experienced operational pilots. He is an expert in the use of the Ju 88 and has served on almost every front and in almost every campaign in Europe, with the possible exception of the Mediterranean area. However, although courageous and capable, it is reported that he is representative of the new generation of bomber pilots whose advancement to high position is blocked by experienced controllers. *The Aeroplane*, January 22, 1943, page 103, 1 illus.

Leaders of the Luftwaffe—XXI. H. J. A. W. This installment of this series consists of biographic data on Major Hermann Graf, popular German hero, called the Luftwaffe's most successful fighter pilot. A former blacksmith's apprentice whose success is due to his own achievements, Graf commands only a fighter squadron

despite his decorations and major's rank. The writer speculates on whether this is due to his inaptitude for administrative duties, lack of influence, or because the Luftwaffe needs him too much for operational tasks to spare him for staff work or high command. Credited with being the victor in more than 200 air combats, Graf is described as courageous, cool headed, and considerate to those under him. As one of Hitler's staunchest followers, he is judged the air officer least likely to betray the Nazi Party or reject its tenets. *The Aeroplane*, January 29, 1943, page 132, 1 illus.

Personnel

Patriotism Knows No Handicap. Andrew R. Boone. An account of how aircraft plants are utilizing physically handicapped people as one answer to the labor shortage problem. The productivity of these people, the variety of jobs they do, and their attitudes toward their work are surveyed. Emphasis is placed upon the fact that they require no special concessions. *Air Progress*, April, 1943, pages 36, 37, 75, 3 illus.

Plants

Factories From Production Lines. A method of factory mass construction as applied by the architects and engineers of the new Pratt & Whitney plant is explained. The mass construction line consists of a series of mobile roof forms, 80 ft. in length and standing side by side for a distance of 1,000 ft. Each of these forms is on wheels fitted to rails. After a week, during which 1,000 ft. of reinforced concrete roofing and the roof-supporting pillars have been poured and set, the forms roll forward their full length. With the concrete slab that forms the floor poured in advance, the building is complete except for the installations of lighting and other inside fixtures.

In addition to a consideration of the construction fundamentals involved, the article deals with the design of the buildings thus erected. It also gives the advantages derived with this method, one of which is the saving in critical materials such as reinforcing steel. *Western Flying*, February, 1943, pages 46, 47, 4 illus.

Plastics and Plywood

Bonding Plastic and Metal. Details are given on the Plastel process for bonding metal to a plastic. Developed by Aero Research, Ltd., this method makes use of metal stabbed all over with small burred holes. The re-entrant edges of these burred holes engage with the plastic during the process and are thus firmly locked together. Improvements in flexural stiffness and dimensional stability are claimed to be obtained which offer a wide range of applications for the composite material. Results of tests are reported and examples of the application of the process are given. *Aircraft Production*, February, 1943, pages 55, 56, 4 illus.

Timber as Aircraft Material. H. W. Maley. This article discusses the results of recent research covering the use of wood in aircraft construction, including work carried out in Australia. Following a review of the disadvantages of timber for aircraft structures, the writer examines the advantages of this material. Reference is made to the availability of aircraft-quality timber and of woodworking facilities that should enable timber industries to cope with greatly increased production. The advance in wood aircraft manufacturing technique which has come with the development of molding processes is described. An outline is presented of the present situation regarding the much discussed subject of wood versus metal. Design problems connected with the use of plywood for aircraft are considered and the advantages of the Vidal process are set forth. *Aircraft*, January, 1943, pages 10–13, 14 illus.

Molded Plastic-Plywood in Aircraft. Robert J. Nebesar. The writer presents a general discussion of plastic plywood and its application to aircraft structures. Because of the importance of weight in aircraft construction, consideration is given to the strength-weight ratios of various woods and metals, data on the subject being furnished in tabular form. Reference is made to the effect of joints on the strength and weight of wood and metal structures. It is stated that for strength-weight ratios at yield points the advantage is chiefly on the side of wood. The compression strength-weight ratios of woods and of metals are also considered.

Four major objections to the use of wood in aircraft and how they have been overcome by modern improvements in materials and methods are

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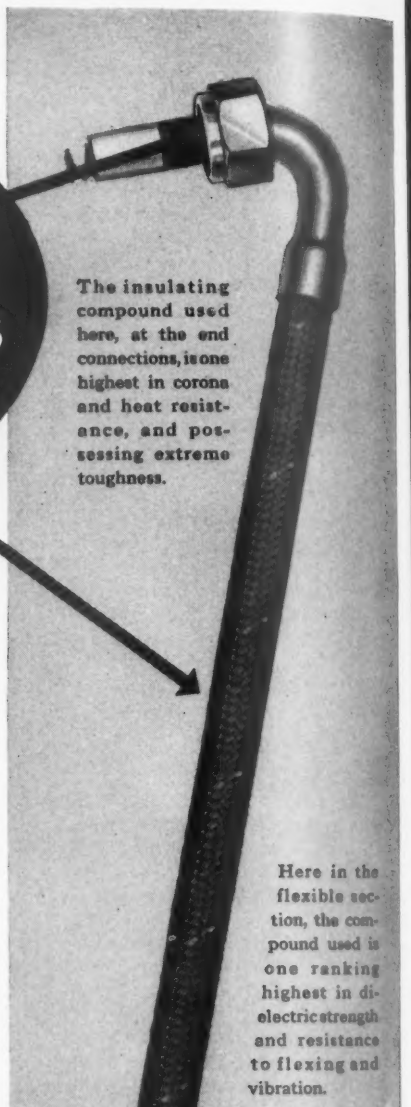

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discussed under sections covering durability, the quantity-production problem, weather resistance, and weight control. Some examples of aircraft structures made of plastic-bonded veneer and woods are described and illustrated. *Modern Plastics*, February, 1943, pages 83–86, 116, 11 illus.; "Molded Plastic-Bonded Veneers and Wood in Aircraft Construction," *Mechanical Engineering*, March, 1943, pages 197–201, 10 illus.

Production

More Wings for Airacobras... by Conveyor Production. Carl F. Lozon. The system whereby wings for the Bell Airacobra are fabricated progressively on a Link-Belt power-driven conveyor is explained in detail. A feature of the system is the fact that all bench and machine work on subassemblies is done parallel to the line and synchronized to its forward movement; there are no tool boxes, power lines, outlets, or connections on floor, dollies, or work stands, and all power-operated tools are suspended at working height from overhead bridging. It is shown how the constant-motion production lines facilitate the employment of unskilled workers and how production time is reduced by fixture design and layout.

The sequence of operations at each stand is described briefly, demonstrating the construction of the wing to its completion. In addition to several photographs, the article is illustrated by a schematic diagram of Bell Aircraft wing-production lines and detail sketch of installations. *Aviation*, February, 1943, pages 126–140, 38 illus.; "Airacobra Factory," *Air Progress*, April, 1943, pages 47–51, 18 illus.

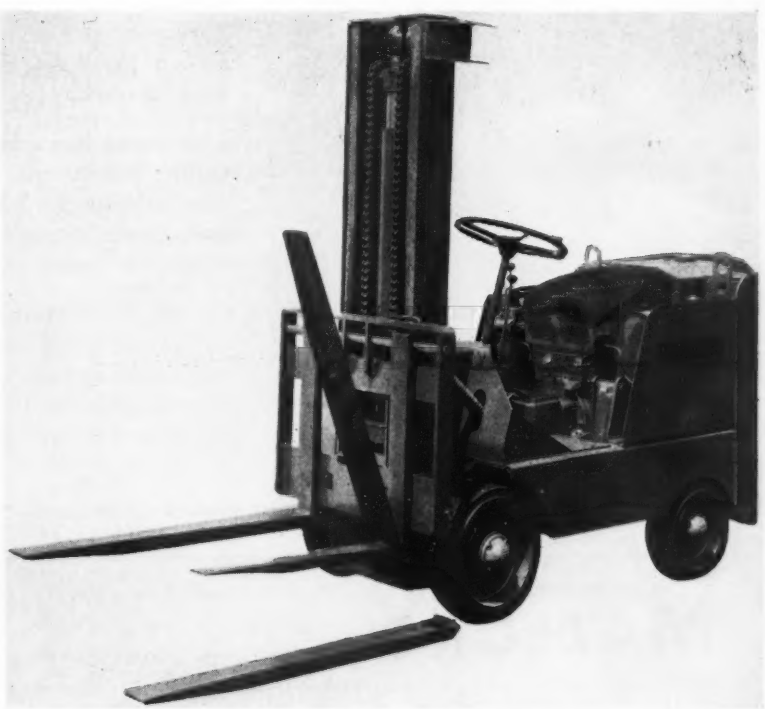
Drop-Hammer Technique. An article describing the production of compound curvatures in sheet metal with the aid of soft metal dies, as carried out by General Aircraft Limited. The advantages of soft metal dies for this purpose are outlined. Shop layout is discussed. Comparing the drop hammer and hand beating processes, an analysis is made of the man-hours required to deliver a given number of panel pressings by the respective methods, which indicates a great advantage in the drop-hammer process for the specific case. The technique of material control is discussed. It is shown that a small additional amount of metal that must be used in making panels with the drop-hammer method is of no importance when consideration is given to the man-hours saved. *Aircraft Production*, February, 1943, pages 57–60, 12 illus.

Plastic Punches. The construction and action of a plastic punch for drop hammers and hydraulic presses are described in detail. This punch, developed by the Vega Aircraft Corporation, is claimed to accomplish consistent forming of sheet metal parts and to increase the amount of their production. A review of the steps necessary in making and using a lead drop-hammer punch serves as a basis for judging the advantages of the plastic punch. Savings in production time and expense are illustrated by comparing the operations of typical Kirksite dies, one with a lead punch and another with a plastic punch. The two methods of making punches are compared, and the limitations on the uses of plastic punches are explained. The punches are described and the precautions necessary in setting them up are outlined. *Western Flying*, February, 1943, pages 42, 43, 86 4, illus.; "Drop Hammer, Hydraulic Press Punches," *Modern Plastics*, February, 1943, pages 68, 69, 130, 132, 5 illus.; "Plastic Punches for Drop Hammer and Hydraulic Press," *Aero Digest*, February, 1943, pages 121, 124, 126, 128, 7 illus.

War Drafts the Man in the Mask. Russell C. Holslag. In this article the writer tells how increased use of arc welding is speeding the production of airplanes, tanks, and ships for war. The various methods of arc welding are outlined and examples of welding operations are described and illustrated. *Popular Science*, April, 1943, pages 82–88, 20 illus.

Planning and Production Control Keep Conveyor Moving. Max Stupar. The coordinator of production of the Bell Aircraft Corporation describes the company's methods of planning and controlling production. It is explained that these are to a considerable extent predicated on 100 per cent lofting system and on the use of continuously moving conveyor lines for final assembly and for some major subassemblies. Sheet metal parts for the Airacobra are made from templates produced in the loft and later duplicated in stamping dies. How the method insures accuracy and speeds the production of parts is described. Tool engineering and the planning of work are carried out by one division, while a second division handles bookkeeping phases, which includes the issuance of orders to the shop for materials. *Wings*, February, 1943, pages 345–347.

Avro Lancaster. Wilfred E. Goff. This second part of a continued article on the production of the Avro Lancaster is mainly concerned with the building of the fuselage. In addition



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to a "birdcage" portion between the main wing spars, there are four components in the complete fuselage, each built in a separate fixture. The article also deals with the construction of the wing tips and wing trailing portion and the track assembly system. The latter is employed for the installation of equipment and services in the fuselage sections and for the final assembly of the complete aircraft. *Aircraft Production*, February, 1943, pages 61–72, 29 illus.

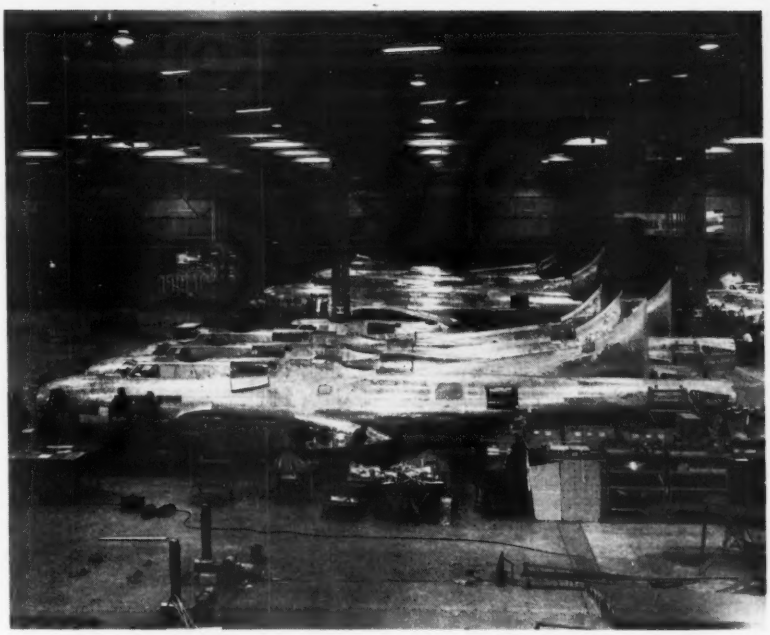
Aircraft Production in Canada. Bruce Keith. A survey of Canada's aircraft industry and its output. Specifications and current data are submitted on the group of nine training and service aircraft being made in Canada. The industry's present position is compared to its prewar status and figures are quoted on the number of planes being produced, the personnel engaged in aircraft manufacture and maintenance plant space involved, and the numbers of companies doing various phases of the work. *Aero Digest*, February, 1943, pages 172–174, 176, 351, 18 illus.

Electron Tube Control of Resistance Welding Machines. B. G. Higgins. The concluding article of a series on tube control in welding is presented. The writer discusses program control and describes two methods of interrupted spot-welding control. Other sections of the article cover the half-cycle bench welder and seam welding control. The panels dealt with in the series are summarized and future developments are discussed. *Sheet Metal Industries*, February, 1943, pages 315–322, 10 illus.

Machining Hispano Cannon Components. Part II. The second of a series of articles describing how the components of the Hispano cannon are machined. Procedures relating to the body and breech block are detailed in this installment, which also covers special machining and inspection fixtures. Topical headings under which the study is divided consist of: roughing operations, breech thread, tappet holes, breech block, ejector clearance, fixture design, and inspection. *Aircraft Production*, February, 1943, pages 78–82, 21 illus.

Proper Tool Salvage Is Everybody's Responsibility. E. L. Derr. Tool salvage methods used by Continental Motors are described. It is emphasized that salvage involves much more than saving scrap materials. Factors evaluated include treatment, material, tool design, rebuilding, complete use, and suitability of coolants. *Wings*, February, 1943, pages 355, 356, 7 illus.

Work Simplification at Martin. Arthur W. Perkins. Methods of facilitating work, as developed by The Glenn L. Martin Company, are detailed. Procedures, machines, engineering adaptations and devices are described. *Aero Digest*, February, 1943, pages 178–180, 10 illus.



Photograph by the Office of War Information

Fuselages for Flying Fortresses take form in one of the Boeing plants.

Time vs. Space. Sidney Swirsky. The conclusion of a two-part article dealing with the importance of plant layout engineering to efficient aircraft production. Various problems of plant layout engineering are discussed, with descriptions given of how solutions are being effected in individual airplane factories. To accomplish greater gains in this field, however, the writer urges the cooperative effort of the entire industry, based on a pooling of information and interests.

This installment also covers the necessity for obtaining complete data on machine loading and work flow before proceeding with any changes. The overhead mechanical conveyor system is featured as an important development affecting the future of plant layout engineering. *Western Flying*, February, 1943, pages 52, 55, 84, 1 illus.

Mobile Assembly Methods. An account of various kinds of handling equipment manufactured by Esavian Ltd. for the mobile assembly of aircraft and components. To illustrate some of the typical production problems solved by the Esavian technique, descriptions are given of mobile handling methods used in connection with several British aircraft types. Applications for the Short Stirling and a single-engined fighter airplane are among those studied. *Aircraft Production*, February, 1943, pages 97–100, 11 illus.

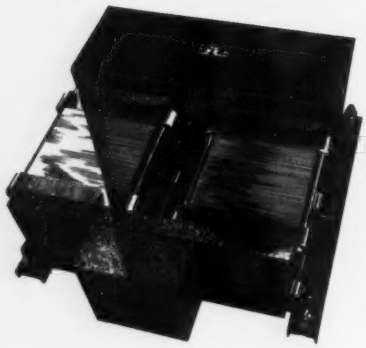
Buick's Cylinder Head Foundry. A description of the production methods practiced at the aluminum foundry which Buick operates for the casting of aircraft-engine cylinder heads. The article covers the whole process from the melting of the alloy to the packing of the finished heads, noting especially refinements, improvements, and departures from conventional procedures. Data are included on the foundry's system of sand reclamation. *Aero Digest*, February, 1943, pages 192, 193, 195, 196, 199, 12 illus.

Induction Furnace for Melting Aluminum Alloys. Manuel Tama. A description is presented of the Ajax-Tama-Wyatt low-frequency induction furnace developed for the melting of aluminum and its alloys. The writer tells how difficulties encountered in the adaptation of the induction furnace to the melting of aluminum were overcome. Details of the construction and operation of the furnace are furnished. It is stated that a feature of the furnace is the absence of hydrogen and water vapor, both especially harmful to aluminum. *Metals and Alloys*, February, 1943, pages 326–329, 6 illus.

Propellers

Contraprops Design and Application. Stephen Williams. The writer traces the development of dual-rotating propellers and discusses mechani-

Industry steadies its "nerves"



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cal and aerodynamic problems connected with the operation of two propellers arranged in tandem and rotating in opposite directions on the same coaxial driveshaft. It is stated that the growing size of power plants and the need for increased speed and altitude are enforcing a movement toward dual-rotating airscrews. Aerodynamic considerations that are making the change necessary are outlined. Reference is made to factors that limit the area and angle of attack of a blade and to difficulties that arise when either the length or the number of blades in a single propeller is increased. Benefits gained with the counterrotating propeller are described. In addition to possessing aerodynamic advantages, this type of propeller is shown to be torqueless. Various early attempts to produce satisfactory counterrotating propellers are outlined. *Air Tech*, February, 1943, pages 8–10, 54, 9 illus.

Radio

Elements of Radio. Lt. Myron Eddy. After explaining that Air Forces radiomen may qualify for 24 different technical specialty ratings, the writer proceeds to outline some of the fundamental principles of radio-frequency communication. Sections of the article deal with the current flow in radio circuits, inductance, and capacity. *Air Tech*, February, 1943, pages 35–37, 6 illus.

Rotating Wing Aircraft

Aviation's Golden Era. Leighton Collins. Describing its potentialities, the writer acclaims the helicopter as the coming medium for private flying. He reports on how the helicopter is operated and explains why direct and uniform responses to control movements can be expected from it. *Air Facts*, March, 1943, pages 10–14.

Helicopters for War? Rowland Carter. The writer comments upon the helicopter experiments being made by the U.S. Army with a view toward their possible adaptation for war. He suggests several military functions that could be performed efficiently by the helicopter but takes into account obstacles that have to be overcome before their use would be feasible. Experiments with the autogiro are also mentioned. *Flying*, March, 1943, pages 38, 138, 1 illus.

Standardization

The Development of a Standard. Glen Aron. The procedure followed by the National Aircraft Standards Committee in obtaining standardization for raw and fabricated aircraft

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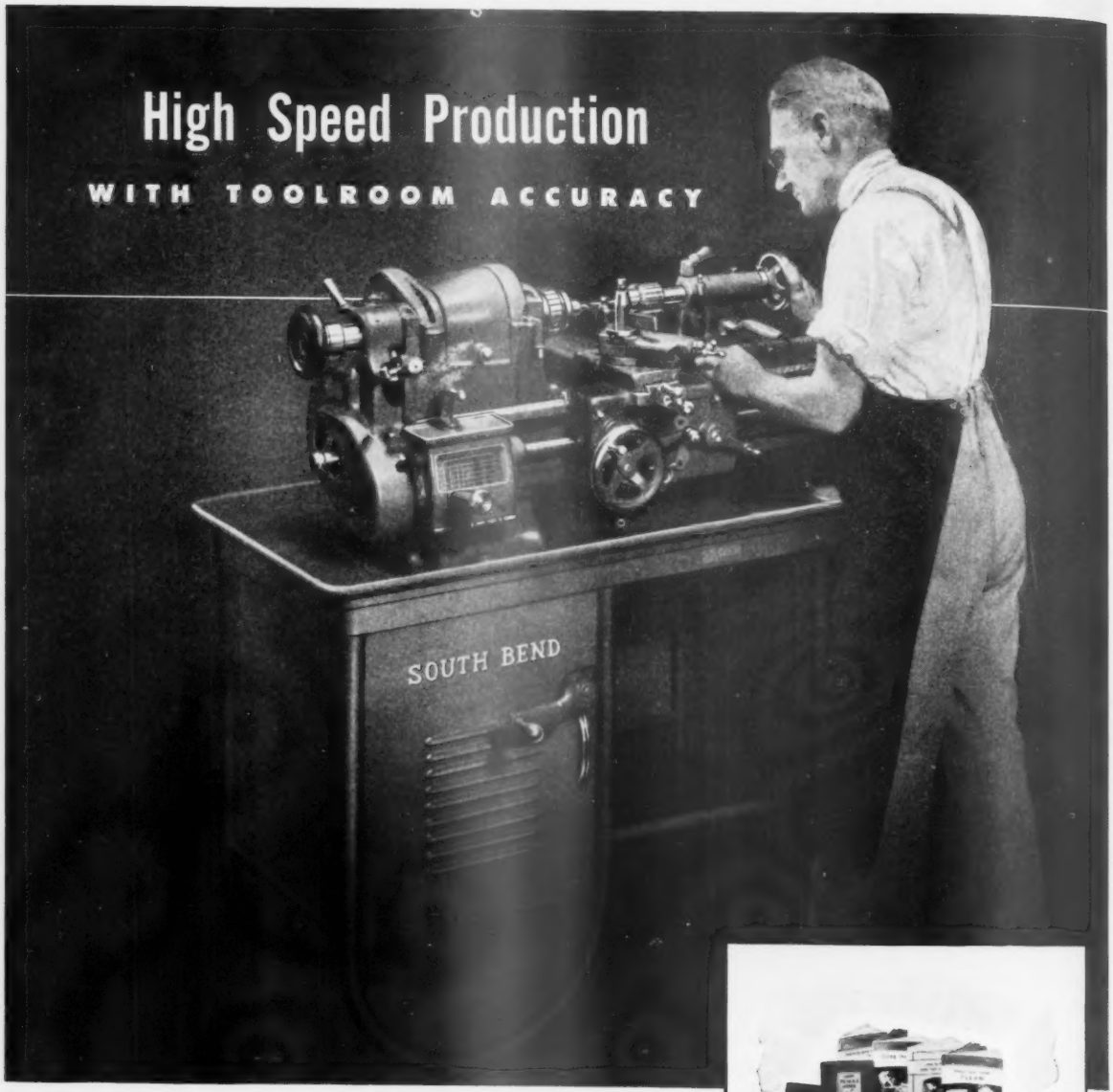

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materials is described and exemplified by two current projects. The two projects are those to provide standards for structural shapes in both extruded and formed-strip sections of aluminum alloy. Simplification of design and procurement problems through the activities of the N.A.S.C. is demonstrated. *Western Flying*, February, 1943, pages 51, 96, 1 illus.

Stress Analysis

Fatigue Characteristics of Natural and Resin-Impregnated, Compressed, Laminated Woods. Forrest B. Fuller and Ture T. Oberg. Because of the increased demand for the production of aircraft, natural woods are being used for primary structural members and propeller blades are being fabricated from both natural and resin-impregnated, compressed, laminated hard woods. Although there are considerable data available on the static properties of wood, information about action under repeated stresses is quite limited. Therefore, fatigue properties have been determined for natural and compressed woods on specimens with and without notches. The rotating beam fatigue machine, which employs a constant load and has been satisfactorily used for testing metals, was also found suitable for testing wood. Tests were run to 100,000,000 reversals or cycles, at relatively low and high frequencies, a few being continued to 500,000,000 cycles. Relatively low notch sensitivity was found for the natural and compressed woods. The ratio of the fatigue limit in bending to the modulus of rupture in static bending was about 0.2 for circular or round sections. *Journal of the Aeronautical Sciences*, March, 1943, pages 81–85, 8 illus.

Effect of Cold-Work and Heat-Treatment on 24ST Aluminum Alloy. Bruce Mitchell. In an endeavor to utilize the strength of 24ST aluminum alloy extrusions above the minimum compressive yield strength of 38,000 lbs. per sq.in. according to specification ANC-5, tests were made in the laboratory of Consolidated Aircraft Corporation. From the data obtained a method of calculating the compressive yield from the tensile properties is developed, as well as some additional information on the general characteristics of the material. Tests with specimens consisting of 54 different hat-type stringers under a number of different conditions of heat-treatment and cold-work are described. Of the specimens, 40 were extruded hats $1^1/_2$ in. deep with a nominal gauge of 0.078 in.; the remaining 14 were rolled hats $1^1/_2$ in. deep made from 24S-T Alclad standard sheets in gauges ranging from 0.072 to 0.128 in. Differences in the mechanical properties of the extruded hats are discussed, with remarks on equalization of the strength by prolonged heat-treatment to establish a uniform base line for the determination of the amount of cold-work in any specimen. Residual cold-work is defined.

The development of the formula is explained and data on the mechanical properties are tabulated. It is concluded that the minimum design allowable strength of 38,000 lbs. per sq.in. can be increased by as much as 30 per cent if a tensile test is made of each extrusion and the true compressive strength of the extrusion is determined by the equation developed. By weeding out the weakest sections or placing them at the points of lowest stress, the maximum compressive yield strength of the plate stringer combination can be realized. *Journal of the Aeronautical Sciences*, March, 1943, pages 86–90, 4 illus.

Stresses in Space-Curved Rings Reinforcing the Edges of Cut-Outs in Monocoque Fuselages. N. J. Hoff. With the object of contributing one step toward the knowledge of the stresses in the neighborhood of openings in monocoque aircraft fuselages, a procedure is developed for the calculation of the stresses in space-curved rings used for reinforcing the edges of openings. The procedure is based on the assumption that the forces that act on the ring are known. Features of the procedure are the use of two systems of coordinates, one fixed to the fuselage and the other traveling along the centerline of the space-curved bar; the determination of all geometric and mechanical properties of the bar as functions of the length of its centerline; the use of vectors for the representation of directions, displacements, rotations, forces, and moments; and the consideration of the effect upon the moments of a non-uniform warping of the cross section of the space-curve bar.

The procedure suggested is described as basically simple but rather laborious. For this reason a detailed investigation is carried out in order to determine the effect of different orientations of the principal axes of inertia of the cross sections, of different values of the ratios of flexural and torsional rigidities, and of a nonuniform warping of the cross sections. From these investigations conclusions are drawn as to when it is permissible to use simplified procedures.

In an appendix the theory of the torsion of the thin-walled open sections is presented. *The Journal of The Royal Aeronautical Society*, February, 1943, pages 35–83, 24 illus.

Two-Spar Wing Stress Analysis. W. J. Goodey. This is the first installment of an article that supersedes a previous article by the writer on the subject. When the original article was written the writer had not been able to obtain a strict mathematical solution to the conditions for minimum strain energy. It is stated that this has now been satisfactorily worked out, and a method of giving numerical solutions is presented which enables any desired degree of accuracy to be obtained. In the previous article no account was taken of the leading-edge skin. Allowance has been made for this in the present article. In the first part of the article the strain energy due to direct stresses in the skin is assumed to be negligible. Because this will not be strictly true of the bottom skin, which is normally under tension, the latter part of the article is devoted to an investigation of the effect of tensile stresses in the bottom skin. *Aircraft Engineering* January, 1943, pages 2–7, 5 illus.

Superchargers

Boost Control. Wigram Maxwell. The action of booster control under varying operating conditions is described. Troubles experienced with the functioning of this device for controlling the supercharger are described. Imperfect action brought about by gas reversal or false pressure in the induction manifold is considered. *Flight*, January 21, 1943, pages 65, 66.

Testing

The Power-Recovery System of Testing Aircraft Engines. G. E. Cassidy, W. L. Wright, and W. A. Mosteller. The advantages obtained with the power-recovery system of testing aircraft engines are enumerated. Consecutive steps in the development of the power-recovery system are described in considerable detail. It is stated that development of the system started with an inquiry made by Pratt & Whitney in 1937 which led to the finding of a better and easier way to test aircraft engines and one in which the greater part of the power generated was recovered. Diagrams presented include the first power-recovery test stand, a curve showing the fundamentals of engine horsepowers and speeds, the schematic

A letter from General Campbell

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DEC 22 1942

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Sincerely yours,

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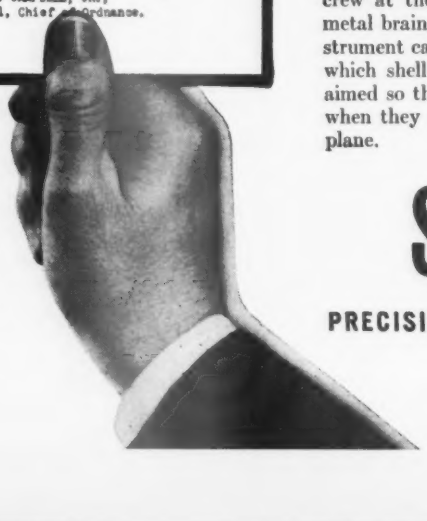
L. H. CAMPBELL, JR.,
Major General, Chief of Ordnance.



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arrangement of an induction generator power-recovery test stand, curves showing the division between horsepower lost and horsepower recovered in testing an engine with three different gear heads, a schematic section of a modern propeller test stand, and a similar diagram of a power-recovery test stand of the synchronous-machine slip-coupling type. *Aero Digest*, February, 1943, pages 223, 224, 227, 268, 271, 7 illus.

Test Experts. William F. Boni. This article deals with the work of the test pilot division of Lockheed-Vega. It tells something of the men who are the test pilots and what their jobs consist of and gives an idea of the rapidity and efficiency with which the planes are tested. *Flying*, March, 1943, page 69, 1 illus.

Tools

Tool Reclamation. J. S. Gillespie. A method is given for reclaiming worn high-speed steel cutters. The process involves brazing tips of Carboloy to the cutting surface of the tool, letting the tip project slightly beyond the edge of the tool, and then grinding the tool to size. When the tool wears down, it can be restored again to normal size by moving the tips out. *Western Flying*, February, 1943, page 80, 2 illus.

Training

Selection, Training, Integration—Three Reasons Why We Have the World's Best Flyers. William S. Friedman. Reasons for the superiority of A.A.F. pilots are investigated. It is stated that careful attention in the selection, training, and integration of pilots has brought this about. The methods used in training American pilots are described in considerable detail. *Popular Science*, April, 1943, pages, 96, 97, 100–102, 210, 212, 3 illus.

Aces for China. George H. Copeland. From a visit to Luke Field, the writer describes the training that Chinese aviation students are receiving in the United States. Graduates of China's military academy with air combat experience behind them, these cadets go through a primary training course at Thunderbird Field, basic training at Williams Field, and advanced training at Luke. How they assimilate their training and their salaries, ranks, living conditions, problems with the English language, purpose, and flying characteristics are noted. *Flying*, March, 1943, pages 26, 27, 114, 118, 4 illus.

Gunnery in Practice. Some notes on the training of R.A.F. gunners. Several devices used for instruction and practice are mentioned. A squadron gunnery officer's typical report is quoted. *Canadian Air Cadet*, February, 1943, pages 12, 24, 1 illus.

The Boeing PT-17 Kaydet used by both the U.S. Army and the U.S. Navy and by the aviation-training services of many of the United Nations as well. Its naval designation is the N2S-3. (*See* "From the Industry.")

Boeing Wichita Model PT-17 Kaydet. (*See* "From the Industry.")

A Post-Graduate School for Pilots. John P. Gilbert. An account of the Controlled Flight Officers' Course given by Northeast Airlines at the University of Vermont for the purpose of supplying the U.S. armed forces with qualified instrument flight instructors. The student body taking this course consists of pilots from the Army, Navy and Marine Corps, as well as civilian trainees. Military students are selected only after they have successfully passed all basic training courses and have shown conspicuous talent for instructing; the civilian students are only those sent to Burlington by the C.A.A. with basic training certificates from C.P.T. schools.

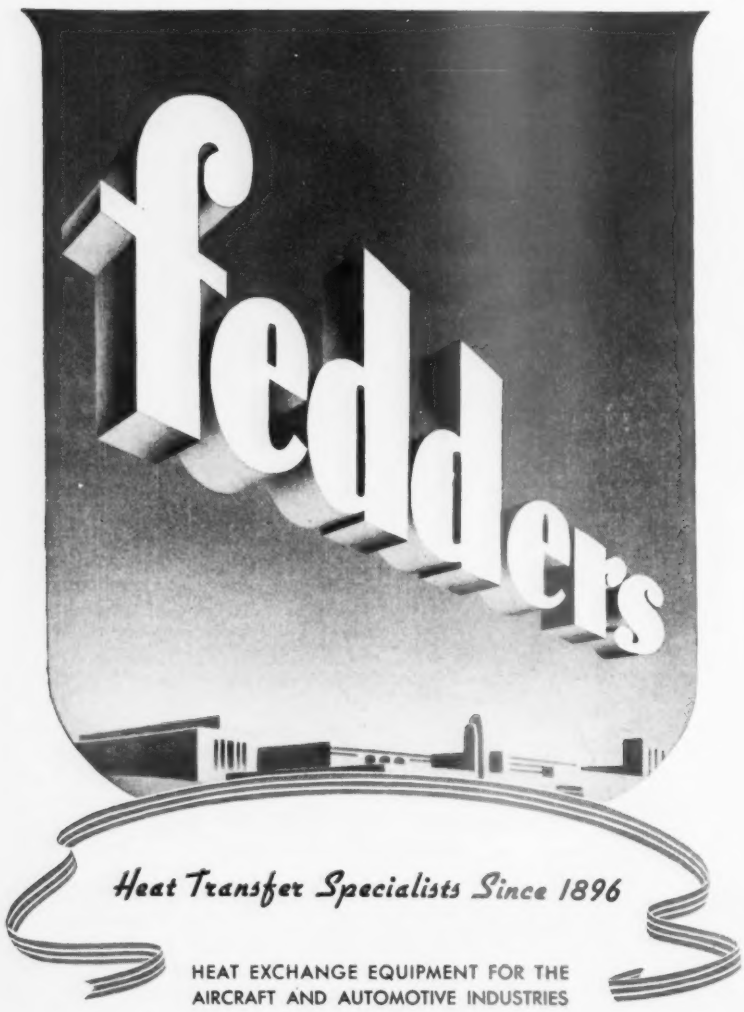
Describing the three components of the course, the article designates them as Stages A, B, and C. Stage A consists of pre-enrollment examinations and tests which last a week. Stage B includes preliminary academic ground school, Link training, and single-motor instrument flight instruction. Stage C covers the advanced ground-school work and multiengined phase of flight training. It is in the latter stage that the student is given full realization of the need for using instrument procedures in handling multiengine equipment even under contact conditions. *The Sportsman Pilot*, Mid-February, 1943, pages 8, 9, 36, 41, 6 illus.

Carriers Coming Up! Lt. Fred Tupper, Jr. The aircraft carrier training program aboard the "U.S.S. Wolverine" is described. At anchor

and under weigh in Lake Michigan, this converted excursion steamer serves as a "substitute" aircraft carrier on which to train all types of carrier personnel. With minor differences, indicated by the article, flight conditions aboard the "Wolverine" are approximately the same as on an ocean-going carrier. Navy pilots who already have 300 flying hours to their credit must have a minimum of eight successful take-offs and landings aboard the Wolverine to qualify for duty in carrier-based planes. *Flying*, March, 1943, pages 42–44, 139, 4 illus.

RAF Chutists. Accompanied by several photographs, some data are presented on the training of Great Britain's paratroopers. As related, their training is shared by the Army and the R.A.F. Flying Training and Army-Cooperation Commands. Differences between the training of British and American parachutists are pointed out. *Air News*, February, 1943, pages 6, 8, 8 illus.

Shake-Up Schedule. Leslie H. Bowman. The effect of the new War Training Service program upon its members is discussed. Designating some of the changes to be instituted, the writer points out that there will be only half as many contractors doing twice the work. Comments are included on what is being done for eliminated operators and a contemplated project for flight training in high schools under C.A.A. supervision. Some of the postwar problems that are now being given consideration by the N.A.T.A. are also discussed. *Southern Flight*, February, 1943, pages 46, 47, 50, 4 illus.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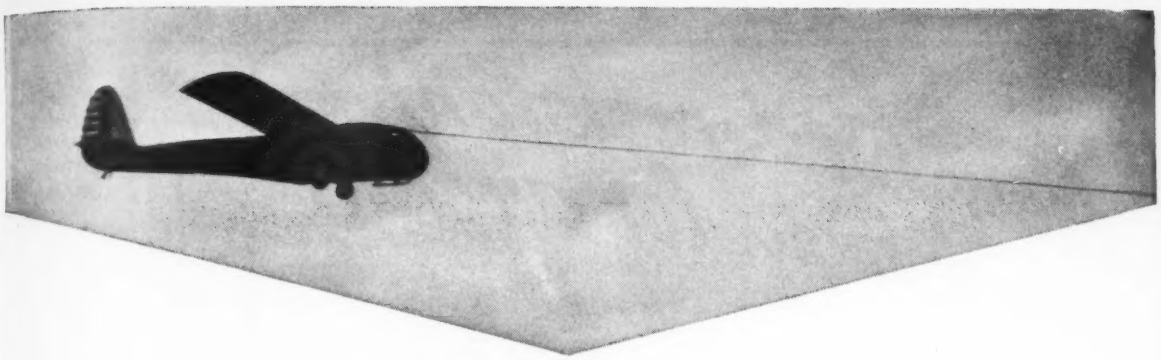
'Observe and Report.' Lt. Thurman E. Bercaw. This article deals with the Army's aerial observer school at Brooks Field, Tex. It outlines the curriculum, describes the military functions of its graduates, and includes a brief history of the field. Officers enter the aerial observer school from all branches of the Army—infantry, artillery, and cavalry. The nine weeks' course is designed to give the student a sound general knowledge of basic army ground tactics and to qualify him in all of the major phases of aerial observation: flying navigation, communications, sketching and mapping, map reading, aerial photography, and aerial gunnery. *Flying*, March, 1943, pages 46–48, 141, 3 illus.

The Story Behind the Patter. Lt. E. Lowell Kelly. The genesis of the C.A.A.'s "Patter" booklet for instructors and "Fundamentals of Basic Flight Maneuvers" study sheets for students is described by the psychologist credited with their development. He explains the technique of the experiments used—how actual flight conversations between pupils and instructors were recorded by radio—and the findings that formed the basis for these instruction aids. The standards that he cites for the descriptions of the maneuvers are that they had to be: (a) aerodynamically correct; (b) simple and clear to the student, using no words not already familiar to him; (c) suitable for actual use in the air; and (d) uniform in their meaning to everyone. *The Sportsman Pilot*, February, 1943, pages 15, 41.

Armorer. This article tells what is taught at the Air Forces' school of armament, Lowry Field, as well as why it is taught. In addition to outlining the course of instruction the armorer receives under the direction of the Air Forces Technical Training Command, it interprets the importance of his work for air combat. The power turret and air gunnery schools, also located at Lowry Field, are mentioned. *Western Flying*, February, 1943, pages 50, 90, 1 illus.

The Civilian Instructor Comes Through. Capt. Allen C. Rankin. The importance of the civilian flying instructor in the military training pro-



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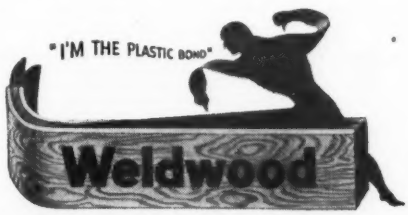
This widely discussed Army transport fully utilizes the many outstanding properties of Aircraft Weldwood, modern plywood at its best.

The country's largest and most successful airplane and glider producers are using Weldwood wherever possible because it is highly dependable and offers just the right combination of essential properties: (1) high strength/weight ratio; (2) permanent immunity to moisture, fungus, rot; (3) heat resistance up to charring point of the wood; (4) split-proof, shatter resistant; (5) tough, durable, easily worked; (6) meets Army & Navy specifications.

Furthermore, aircraft of Weldwood are built *fast*—at economical cost.

Prefabricated floor boards, navigators' tables, rigid interior structures and partitions, wing tips, angles and other ready-to-use parts of Weldwood further simplify and speed production. Expanded manufacturing facilities plus new engineering and technical developments make reasonably prompt delivery dates possible.

Back of Weldwood is an organization that offers unmatched production facilities together with a qualified technical staff that includes engineers, chemists and wood technologists. Write today for illustrated booklet and complete information.

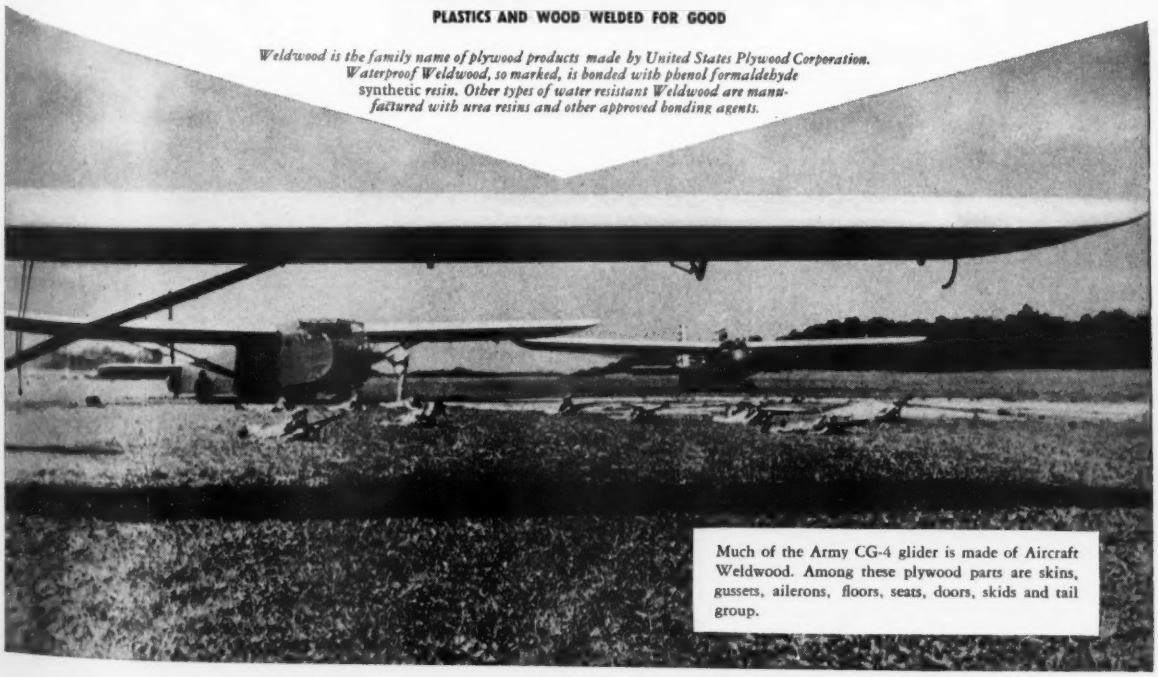


NEW PLASTIC GLUE

Weldwood Plastic Resin Waterproof Glue . . . makes strong, permanent joints. Readily mixed with cold water. Available in convenient sizes, 1⅛ oz. cans up to 100 lb. drums. Literature, FREE sample on request.

PLASTICS AND WOOD WELDED FOR GOOD

Weldwood is the family name of plywood products made by United States Plywood Corporation. Waterproof Weldwood, so marked, is bonded with phenol formaldehyde synthetic resin. Other types of water resistant Weldwood are manufactured with urea resins and other approved bonding agents.



Much of the Army CG-4 glider is made of Aircraft Weldwood. Among these plywood parts are skins, gussets, ailerons, floors, seats, doors, skids and tail group.

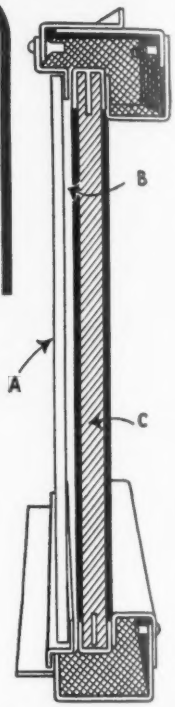
New bird-resistant windshield for aircraft

INTERLAYER OF DU PONT "Butacite"* TO HELP PROTECT PILOTS IN COLLISION WITH LARGE BIRDS

Picture a large bird hurtling through an airplane windshield—spraying the pilot with broken glass—bursting through the bulkhead—racing the length of the cabin—piercing the baggage compartment! Accidents like this sometimes happen even at altitudes of 8000 feet, when pilots collide with ducks, wild geese, eagles—even sea-gulls.

Recently, under the auspices of the Civil Aeronautics Administration, researchers began development of a new-type windshield to protect pilots from such high-velocity impacts. The astounding result of their tests: a windshield laminated with special Du Pont "Butacite" polyvinyl acetal resin—capable of withstanding the impact of fifteen-pound birds at velocities of over 200 miles per hour! Follow this amazing story in pictures, below.

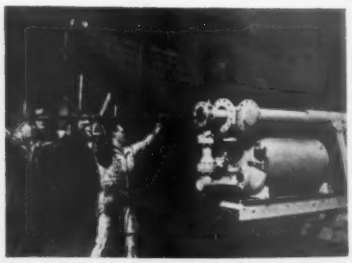
*"*Butacite*" *polyvinyl acetal resin*



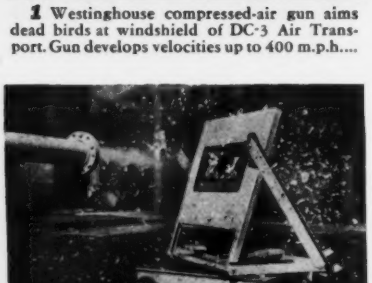
Cross-section of windshield shows (a) ¼" glass front pane, (b) hot air space for deicing and maintenance of correct temperature for maximum impact strength of laminated section, (c) laminated section of ½" "Butacite" between ⅛" semi-tempered glass panes. Metal strips, imbedded in flange of "Butacite," allow firm bolting of plastic to metal framework.

1 Westinghouse compressed-air gun aims dead birds at windshield of DC-3 Air Transport. Gun develops velocities up to 400 m.p.h....

2 Specially-constructed framework, patterned after that of DC-3, holds test windshields as targets.

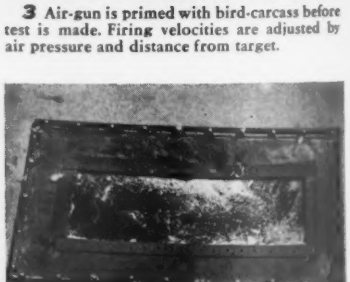


3 Air-gun is primed with bird-carcass before test is made. Firing velocities are adjusted by air pressure and distance from target.



4 Gun is fired. Ordinary windshield is shattered completely by dead-bird projectile shot at low velocity.

5 Carcass fired at new-type windshield shatters glass front-pane, but bounces off the laminated section.



6 Laminated section cracks but remains intact. Thus Du Pont "Butacite" will provide greater safety for the men who fly the skyways.

This application of "Butacite" polyvinyl acetal resin is one example of how Du Pont Plastics Technicians are helping to provide things for greater safety and efficiency in war, as well as in peace. Let us help you solve your development problems! Write: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Arlington, New Jersey.

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Better Things for Better Living . . . THROUGH CHEMISTRY

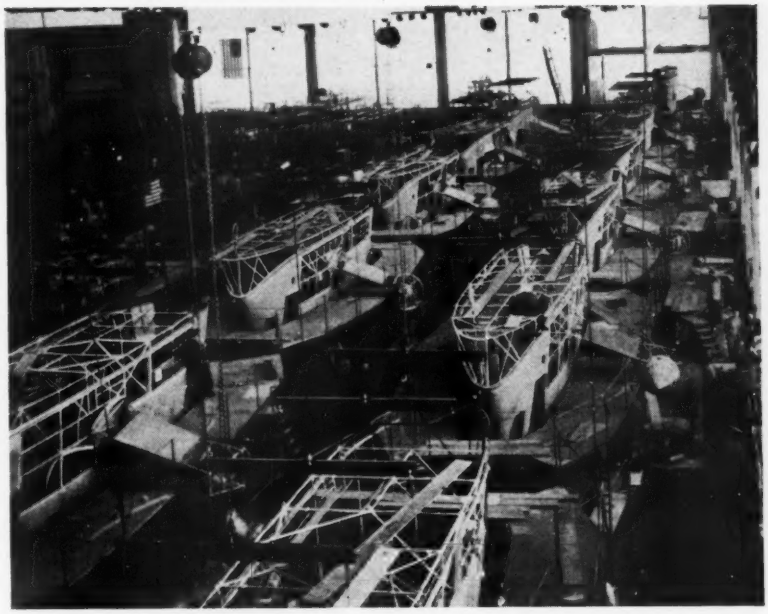
gram is emphasized. The writer shows why the instructor must be a precise pilot, a good psychologist, a supersalesman, and an infinitely patient teacher. *Flying*, March, 1943, pages 55, 56, 100, 4 illus.

Reading Aircraft Blueprints. Francis L. Goff and Lloyd R. Novak. An elementary description of how to read blueprints used in aircraft production is presented. Sections of the article deal with basic dimensions, progressive dimensions, terms used in connection with castings, forgings and machine parts, miscellaneous standards, and assembly blueprints. A list of abbreviations is also included. *The Draftsman*, February, 1943, pages 10, 11, 38, 48, 2 illus.

"College of the Air." Frank Maher. An article on Parks Air College and its president, Oliver L. Parks. The history and development of the school is unfolded, its various courses of instruction are outlined and details are given about each of its Army Air Forces primary flight training centers—Parks Air College at East St. Louis, Ill.; Alabama Institute of Aeronautics at Tuscaloosa; Missouri Institute of Aeronautics at Sikeston; Mississippi Institute of Aeronautics at Jackson; and the Cape Institute of Aeronautics at Cape Girardeau, Mo. A description of the main school, data on the kinds of equipment used, and information about scholarship standards and requirements are included. *The American Pilot*, February, 1943, pages 20–23, 16 illus.

XC—And Back. Lt. Ken Lester. A detailed study of the navigational training given to Army Air Forces student pilots. The writer follows the student from the first week of ground work to actual cross-country flight exercises, tracing the gradual assimilation of the three navigational methods taught—pilotage, dead reckoning, and radio navigation. Among the several navigational aids that the student learns to use are: a compact computer whose two sides, reduced to their essentials, are a circular slide rule; a rotative transparent disc for setting up wind triangles; the altimeter; and the magnetic compass. With their tactical values defined, the exercises examined include search, interception, low-altitude navigation, high-altitude navigation, and night flying missions. *Air Facts*, March, 1943, pages 24–34, 3 illus.

Plastic Models in War Training. The use of plastic models of drawing problems as applied to the training of craftsmen for war industries is described. It is explained that with the employment of transparent plastic sheets the various angles and planes of intricate figures become entirely visible in any projection and in any perspective. The method is stated to be particularly useful in courses on die design. *The Draftsman*, February, 1943, page 32, 2 illus.



Streamlined control cars for U.S. Navy blimps on the production line in one of the Goodyear Aircraft Corporation plants.

Air Force on File. James Montagnes. The R.C.A.F.'s system for keeping track of all trainees under its jurisdiction is outlined. The article tells how the records branch at Ottawa posts daily reports of all personnel changes. It also includes information on the kind of data kept on each man. The record starts with the moment a recruit is given papers to fill out and goes right through to the time when he is discharged or killed in action...involving not only details on his progress through the R.C.A.F., his various postings, training activities, identification card with photograph and thumbprint but also on the steps taken to notify his family if he dies on duty, what disposal is made of his belongings, and what pensions are due his dependents. *Flying*, March, 1943, pages 102, 122, 3 illus.

Camp Boardwalk. Martha S. Woolley and Pete Martin. An account is given of the conversion of Atlantic City from a seashore resort to quarters for the Air Forces Technical Training Command. Its suitability and adaptation to the needs of the Command is depicted. A discussion of the financial effect of the transition upon the town's merchants, hotel keepers, and business people is also included. *The Saturday Evening Post*, February, 1943, pages 26, 27, 48, 8 illus.

Warfare

Winter Air War. Leonard Engel. A discussion of winter weather conditions in Europe and some of the problems of air warfare created by them. Special equipment and techniques developed to combat mechanical difficulties caused by extreme cold are examined. In western Europe, primary problems are designated as forecasting, visibility, and ice; on the Nazi-Soviet front, snow and the intense cold are named as the greatest obstacles. It is stated that in the latter zone—with the advantages of prediction, equipment, and knowledge on the side of the Soviets—Nazi operations are hindered more completely by weather phenomena than are those of the Russians. *Air News*, February, 1943, pages 23–26, 15 illus.

Bombing Tactics. Lt. Col. Georgi Shchetchikov. Soviet Air Force methods for combating enemy antiaircraft defense are outlined. Highly maneuverable aircraft carrying large loads of high-explosive bombs, specially designed for such operations, and large-caliber aircraft guns capable of firing at steep angles are designated as the best weapons for this purpose. The extensive use of camouflage is recommended as a means of evading detection. Several features of Germany's system of antiaircraft defense are also depicted. *Flight*, January 21, 1943, page 63.

La Seguridad y la Economia en los Polvorines Subterraneos (Safety and Economy of Underground Powder Storage Rooms). Benjamin

Llorca Gisbert. A technical study on dugouts for powder storage which the writer considers necessary in view of the fact that air attacks may take place anywhere in the interior of the country. He bases his investigation on researches made by the French and Italian governments with regard to the penetration power of various types of bombs, the line of least resistance of the dugouts, and their capacity, according to the type of explosives to be stored. Construction data together with mathematical formulas and equations are presented. *Revista de Aeronautica*, October, 1942, pages 251, 254, 2 illus.

Russian Long-Range Bombing. Lt. Col. Nicolai Denisov. A report on the operations of the Soviet Long-Range Bomber Command, from a Moscow communique. Strategic bombing raids on German industrial centers, attacks on the enemy's rear lines, participation in front-line operations, protection of convoys, and bombing of railway and other ground targets are among the heavy-bomber actions described. *The Aeroplane*, January 22, 1943, pages 95–97, 3 illus.

Can Tokyo Take It? Irving Wallace. The vulnerability of Tokyo to air attack is depicted. Based on the experiences of 15 days of intensive air-raid drills and war games in Tokyo, the writer reports that not only is the city potential timber for a holocaust but its air defenses are inadequate, its fire-fighting power and medical resources are totally insufficient, its people are unorganized, and its factories are unprotected. He also claims that, like Tokyo, the other important cities of the island could not hold out against sustained air attacks. *Skyways*, March, 1943, pages 30–33, 84, 14 illus.

Mosquitoes in the Day Offensive. The performance characteristics of the de Havilland Mosquito are reported. The procedure of a typical Mosquito attack is followed from the time the crew members gather until the planes return to their home base. It is stated that the part these bombers have been taking in the offensive of British Fighter, Bomber, and Army Co-operation commands for the past several months has been directed particularly against the transport and communications systems under the control of the Germans. Aerodynamic efficiency and sturdy construction are credited with contributing to the excellent defensive characteristics of the Mosquito. *The Aeroplane*, January 15, 1943, pages 70, 71, 2 illus.; "Mosquito Squadron," *Flight*, January 14, 1943, pages 35–37, 10 illus.

Welding

Survey of Arc-Welding Practice in the Aircraft Industry. Maurice Nelles. This paper presents summarized results of a survey of arc-welding practice made in 1942 under the auspices of the Engineering Foundation utilizing the facilities of the Aeronautical Chamber of Commerce. The survey covered most of the large aircraft companies and several of the smaller concerns. Information is furnished on welding equipment, materials, special techniques, processing, heat-treatment, testing, and inspection. Subjects for further research are suggested. *The Welding Journal*, February, 1943, pages 78-s, 79-s, 1 illus.

Arc Welding Aircraft Structures. W. S. Evans. The general procedure for determining whether or not a part should be fabricated with arc welding is discussed, and an outline is given of process development procedure when parts are to be welded. Factors that must be taken into consideration in the development of a final design are proper joint selection and the selection of the material best suited to meet all requirements. The method of forming and the location of the weld must also be given attention. The estab-

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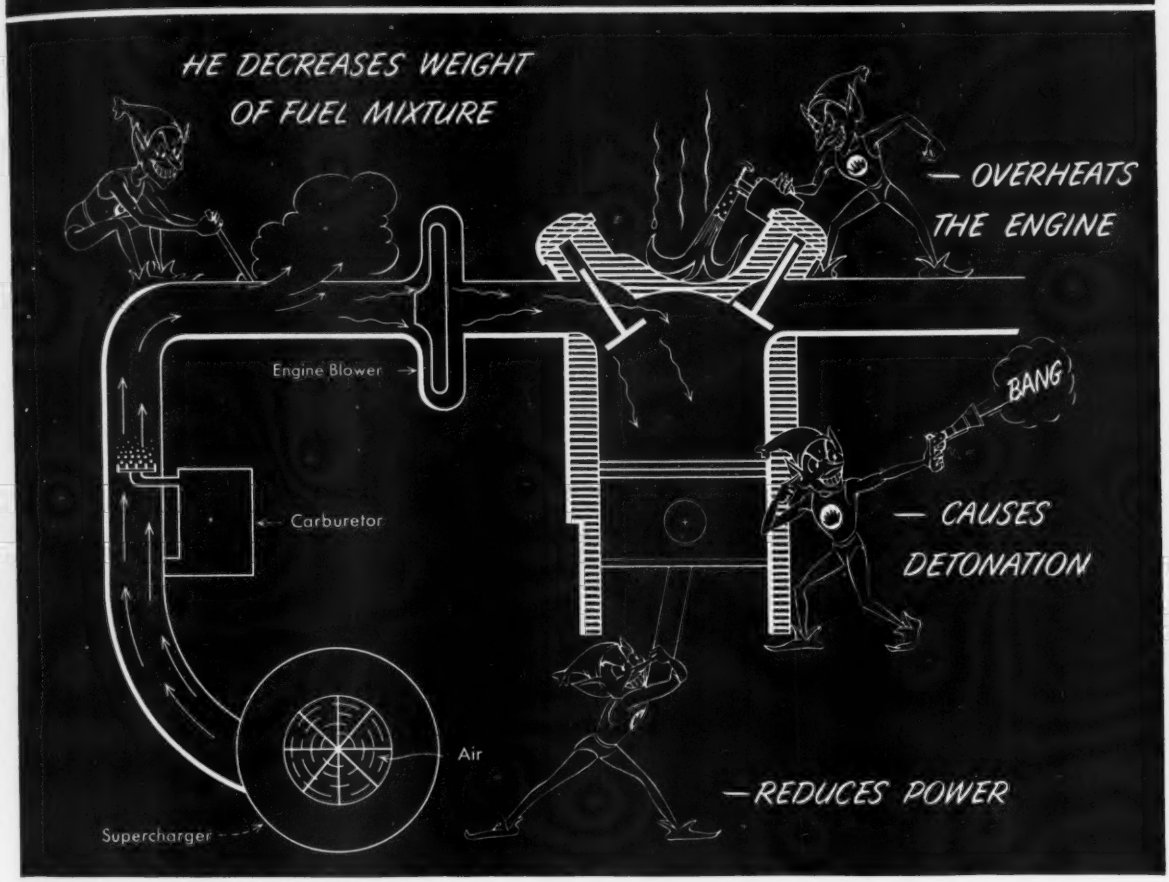
Hot air is the supercharger "gremlin"...



AiResearch Intercoolers *provide control that helps raise critical altitudes*

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And, the entire assembly is anodized for protection against corrosion ... another reason why the AiResearch Intercooler provides freedom from maintenance trouble.

AiResearch Intercoolers are manufactured in flattened or round tubular units ... adaptable to every shape and size requirement. And the intercooling experience of the engineers who developed them is available to all aircraft manufacturers. Inquiries are invited.

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In the piercing cold and rarefied atmosphere of the sub-stratosphere, where air supremacy is gained, spark plugs must provide their life-giving sparks under most abnormal conditions. To meet these abnormal conditions, exhaustive research, specialized engineering and uncompromising manufacturing standards are combined to give our air forces spark plugs with the same characteristic dependability that has made Champion Spark Plugs the ultimate for earth-bound engines.

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5. Homogeneous structure eliminates air spaces which cause current leakage.
6. Easily cleaned and serviced — no specialized equipment or factory returns necessary.
7. Scientifically controlled manufacture.

C26—Unshielded

USE CHAMPIONS AND FLY WITH CONFIDENCE

lishing of shop procedure is discussed. Tube-forming assembly in a landing-gear drag brace is described. *Aero Digest*, February, 1943, pages 200, 205, 206, 209, 210, 355–357, 7 illus.

Weldability of NE 8630 Steel for Aircraft Structures and a Suggested Specification for Weld Metals. A. R. Lytle and K. H. Koopman. This paper deals with two phases of the welding of aircraft materials—namely, the welding characteristics of NE 8630 steel as compared with S.A.E. X4130 steel, and the suggestion of a method of specifying the properties to be required of the weld metals. It is concluded that the weldability of NE 8630 steel sheet as determined on one heat that was considered to be satisfactorily representative of this new type of steel is at least equal to that of S.A.E. X4130 steel in the thicknesses tested. This embraces flowing quality, hardness, tensile strength, and bend ductility after welding. It is stated that some welding rods regularly used for aircraft provide weld metal that does not meet the requirements of sound weld-engineering design. The application of a suggested specification covering minimum tensile strength and bend elongation requirements would lead to a satisfactory balance between the physical properties of weld and base metals.

Residual stresses were produced under controlled conditions and were measured in a nondestructive way by means of x-rays. It was found that residual stresses will not affect the safety of a ductile material subject to a static and repeated load if the article is homogeneous and without notches and if these stresses act in no more than two directions. The notch impact resistance of such a material is also unaffected by a biaxial state of stress. With this information it is possible to attack the problem of residual stress in actual welding in a more appropriate way, by concentrating attention on the role of heterogeneity, surface irregularities and more complicated states of residual stress. *The Welding Journal*, February, 1943, pages 82-s–93-s, 24 illus.

The Common Mechanical Properties of Carbon-Steel Weld Metal in Electric Arc Welding. Orville T. Barnett. The writer reviews a standard test procedure for arriving at the mechanical properties of weld deposits, highlighting the most influential factors. He discusses elementary controlling influences with the object of furnishing a better understanding of the relationship between the physical properties of welds in actual weldments. *The Welding Journal*, February, 1943, pages 108–113, 8 illus.

Unusual Resistance Welding Developments and Operations. R. T. Gillette. This article deals with welding developments and operations with which the welder is not familiar. It is explained that a welding job is unusual in inverse ratio to the welder's familiarity with it. The subject is confined to a description of new and unusual products that are made for peacetime use and which may not be found in the average welding department. *The Welding Journal*, February, 1943, pages 116–118, 12 illus.

Wind Tunnels

Wind-Tunnel Cooling. Arthur N. Tifford. The problem of cooling wind tunnels has been analyzed. It has been found that the turning vanes and the throat of the tunnel are the best places for using surface cooling.

As the operating speeds of tunnels increase, it becomes more and more difficult to cool the tunnel surfaces, and it becomes necessary to install a radiator in the tunnel. The detrimental effect of the use of a cooling radiator is small when the tunnel cross section is expanded ahead of the radiator. The percentage reduction in the energy ratio of the tunnel is given by the ratio of twice the adiabatic temperature rise, when the air in the radiator is brought to rest, to the temperature difference available for cooling, all multiplied by the ratio of the density of the air in the radiator to the density of the air in the throat of the tunnel.

The length-diameter ratio of the air passages of the cooler is determined by the cooling capacity required. The actual size of the air passages is limited, on the one hand, by the space available and, on the other, by the magnitude of the allowable power expenditure pushing the coolant through the radiator. The size of the radiator whose coolant power expenditure is equal to the power expended in the rest of the coolant circuit will, in general, be found to be about the best practical compromise. *Journal of the Aeronautical Sciences*, March, 1943, pages 98–100.

Miscellaneous

The World's Best Planes. Peter Masefield, Major Nathaniel F. Silsbee, and Hanson W. Baldwin name their separate selections for the "best" planes in different classifications. The types listed are heavy, medium, and light bombers; land-based and naval torpedo bombers; naval dive and patrol bombers; Army scouts; single-seater, naval, and night fighters; transport seaplanes and transport landplanes. *Skyways*, February, 1943, pages 46–48, 4 illus.

What's in a Name? A critical commentary on the systems used by the U.S. Air Forces to designate their aircraft. The use of independent sets of symbols by the Army and Navy is censured. A list of U.S. Army Air Force and U.S. Navy aircraft type symbols is given together with the manufacturer's letter symbols employed by the Navy. *Flight*, December 10, 1942, page 638.

Maintenance of Battery-Powered Plant Trucks. F. L. Sahlmann. Suggestions are offered on maintenance procedures to prolong the usefulness of battery-operated industrial trucks. These are separated into two classifications: work to be done on monthly inspections and operations included in an annual overhaul. Specific consideration is given to the following parts: the commutator, pump motor, controller, contactor, and accelerating resistor. *Aviation*, January, 1943, pages 155, 157, 158, 323, 324, 7 illus.

Fire Control. The prevention and control of aircraft fires is briefly discussed. It is explained that fire prevention consists largely of taking precautions in storing gasoline and in designing fuel tanks and lines so there is a minimum danger of leakage. How fires are put out by cutting off the oxygen supply, which is usually accomplished with carbon-dioxide extinguishers, is explained. *Air News*, January, 1943, pages 54, 55, 6 illus.

Safety Devices for Aviation Plants. D. S. Frederick. Safety devices that are reducing the number of industrial accidents in aircraft plants are described and illustrated. Among these are a transparent drill-press skirt used at Consolidated, acrylic saw shields in use at Republic, tiltable shields to protect Beechcraft fuselage workers, acrylic eyeshields used at North American, and transparent shields used at Bell Aircraft to prevent spattering of molten metal from soldering pots. *Modern Plastics*, February, 1943, pages 48, 49, 7 illus.

Dixie Dusters. Donn Hale Munson. Crop-dusting operations, their purpose, and methods of procedure are described. Stressing the value of crop dusting to the planter, the article discusses some of the problems, as well as the hazards, connected with this branch of flying. *Flying*, March, 1943, pages 84, 98, 100, 1 illus.

Group of 1943 Science Talent Search Winners leaving the Pan-American Union Building after discussing South American relations with Dr. L. S. Rowe, Director-General.

Prospecting for future scientists

Every step forward in science brings with it a need for more scientists. Not technicians merely, but men and women who are capable of creative achievement.

Where are they to be found?

It seems highly probable that aptitude for creative achievement in science can be discovered as early as the senior year in high school.

It is quite certain that early discovery of ability helps crystallize the interests of the students and stimulates them to further activity.

For these reasons, Science Service, Science Clubs of America and Westinghouse are cooperating in an annual Science Talent Search. Methods employed in the Science Talent Search, including the science aptitude tests, were devised by Dr. Harold A. Edgerton, Ohio State University, and Dr. Steuart Henderson Britt, Office of Psychological Personnel, National Research Council.

Each year, 40 boys and girls selected on the basis of the criteria set up by Dr. Edgerton and Dr. Britt, are taken to Washington as guests of Westinghouse. There, after further examinations and interviews, those who qualify receive Westinghouse Science Scholarships ranging from $100 to $2400.

Last year, 20 Westinghouse Science Scholarships were awarded, but every boy and girl selected for the trip received offers of scholarship help from leading colleges and universities.

Every one entered college.

Every one is making a scholastic record considerably above the average.

Since the Science Talent Search is only in its second year, there are yet no data on the correlation between aptitude as measured by the methods employed and actual achievement in science. Dr. Edgerton and Dr. Britt have, however, begun a projected ten-year study of these boys and girls, covering their work in college and the early part of their after-college careers.

Full information on the Science Talent Search, including reprint of an article by Dr. Edgerton and Dr. Britt describing the methods employed, will be sent on request. Write to Science Service, 1719 N Street, Washington, D. C., or to School Service, Westinghouse Electric & Manufacturing Co., 306 Fourth Ave., Pittsburgh, Pa.

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Government Publications

Army Air Forces

What You See Won't Hurt You. Lt. Charles W. Tribken, Jr. A U.S. Army Air Forces pilot stresses the importance of sighting the enemy before he attacks. Illustrating his points by the narration of a typical desert mission, he presents his observations on how German sky fighting is characterized by a set pattern of positions and actions and the fighting tactics that must be used to combat this pattern. *Air Force*, March, 1943.

The Army's Flying Windmill. Col. H. F. Gregory. The results of the helicopter's eight months of flight testing, demonstration, and pilot training at Wright Field are reported. Although certain limitations are acknowledged, the advantages of the helicopter for liaison and other specialized military applications are given. The article also includes a brief description of the helicopter and its operation. *Air Force*, March, 1943.

Dawn of a New Era. C. L. Morris. The pilot's story of the first cross-country helicopter flight in the Western Hemisphere, when a U.S. Army helicopter was delivered from the Sikorsky plant in Connecticut to Wright Field, O. Actually consisting of 16 separate flights, the flight repeatedly established and exceeded the unofficial American air-line distance record for helicopters, finally setting a new figure at 92 air-line miles. It also set a new unofficial world endurance record. *Air Force*, March, 1943.

Checking and Double-Checking Navigation Devices. Col. Thomas L. Thurlow. A discussion of the examination and testing problems of the Army Air Forces' navigation instrument laboratories at Wright Field. It is stated that, while many navigational "inventions" are submitted and all receive full consideration, few attain Air Force standards or offer anything that has not been known before to navigational experts. The systems adopted are those that are serviceable under all flight conditions, require less than 4 min. of computation, and can be economically constructed, installed, and maintained.

The article includes details on several devices and methods that the Army Air Forces uses. Among these are the Air Almanac, the Astro-Compass, a dead-reckoning computer, the Astrograph, and the Star Altitude Curves. A synchronous ground speed meter, developed by a Medical Corps officer, is mentioned. *Air Force*, March, 1943.

Piggy Back. Lt. John Truesdell. A description of how the "piggy back" seat was evolved and the advantages it will afford. The term applies to a new two-seat arrangement in the small single-seat cockpit of the Lockheed P-38 which will permit an extra person to fly with the pilot. Sponsored by the Directorate of Flying Safety and developed for instructional purposes, it will enable instructors to check cadets' actual operation of the plane. The extension of the dual-seat arrangement to other single-seater fighters is expected. *Air Force*, March, 1943.

The Meaning of Flight Control. Lt. Col. George C. Price. The director of a new unit in the Army Air Forces explains its purpose and operation. He states that the two places where the activities of the Flight Control division will be most apparent are in the operations offices and in flight on the airways. The article tells of scheduled changes in airways traffic control, how pilots will be affected, and how procedures in operations offices will be prescribed by Flight Control, which will conduct an inspection service in line with these procedures. *Air Force*, March, 1943.

What Kind of Officers Will They Make? Major W. R. Cunningham, Jr. A discussion of the qualities necessary to make a good officer and the indoctrination of air force cadets with the high principles of leadership. The inseparability of discipline and morale is stressed. *Air Force*, March, 1943.

Camouflage Is a Must. Lt. George Bradshaw. Dealing with the basic principles of camouflage, this article emphasizes the fact that camouflage should not be limited to experts. It expresses the belief that every member of the armed forces should be versed in the fundamentals of concealment and how to confuse the enemy. Primary data on relative lightness and darkness, color, and texture are presented. The camouflage courses given at March Field, Calif., and Fort Belvoir, Va., are mentioned. The article is supplemented by a table of "do's" and "don'ts" for the neophyte camoufleur. *Air Force*, March, 1943.

Observations on the Russian Front. Major John C. Henry. An "eye-witness" account of the Soviet offensive by an American Army officer who was one of the first three foreign observers to witness actual combat operations of the Russian Army. Activities are reported on two sectors: the Don-Stalingrad front and the Caucasus. Although it is stated that because of unfavorable flying weather relatively little air action was seen, the preparatory and contributing part played by air strength is featured. *Air Force*, March, 1943.

A New Aspect of Flyer Fatigue. Lt. Col. David B. Dill. A consideration of the irritants that are thought responsible for a flier's fatigue. With the causes both physical and psychologic, some of those described are peculiar to fliers and the war, while others are similar to those experienced by industrial workers at home. The article lists remedial measures, emphasizing two of them: active participation in sports and cheering news from home. *Air Force*, March, 1943.

Information—If You Please! Lt. Col. H. O. Russell. The functions of the Arctic, Desert and Tropic Information Center at Eglin Field, Fla., are outlined by its director. Established to serve the Army Air Forces, this center collects, evaluates, prepares, and disseminates information on all problems arising out of arctic, desert, and tropic operations. The methods by which its information is gathered and collated are noted. *Air Force*, March, 1943.

National Advisory Committee for Aeronautics

Theory of Heat Transfer in Smooth and Rough Pipes. G. D. Mattioli. Translation of an article "Theorie der Wärmeübertragung in glatten und rauhen Rohren," from *Forschung auf dem Gebiete des Ingenieurwesens*, July-August, 1940. The heat transfer accompanying turbulent flow in tubes has been treated by a new theory of wall turbulence, and a formula for smooth tubes has been derived which is asymptotic at

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$Re \to \infty$. It agrees well with the data available to date. The formula also holds for the flow along a flat plate if λ is based on the velocity far away. For rough tubes, the unit conductance is shown to be a function of kv^*/ν; the two empirical constants (Δ_r, n) which appear in Eq. (52) cannot yet be determined because of lack of experimental data. *N.A.C.A. T.M. No. 1037*, December, 1942.

Piezoelectric Instruments of High Natural Frequency Vibration Characteristics and Protection Against Interference by Mass Forces. Werner Gohlke. Translation of an article "Quarzdruckmessgeräte hoher Eigenfrequenz Schwingungseigenschaften und Abhilfe gegen die Störung durch Massenkräfte," *VDI-Forschungsheft*, March-April, 1941. The exploration of the processes accompanying engine combustion demands quick-responding pressure-recording instruments, among which the piezoelectric type has found widespread use because of its especially propitious properties as vibration-recording instruments for high frequencies. Lacking appropriate test methods, the potential errors of piezoelectric recorders in dynamic measurements could only be estimated up to now.

In the present report a test method is described by means of which the resonance curves of the piezoelectric pickup can be determined; hence, an instrumental appraisal of the vibration characteristics of piezoelectric recorders is obtainable. *N.A.C.A. T.M. No. 1040*, February, 1943.

Tail Buffeting. G. Abdrashitov. Report No. 395 of the Central Aero-Hydrodynamical Institute, Moscow, 1939. An approximate theory of buffeting is presented, based on the assumption of harmonic disturbing forces. Two cases of buffeting are considered: namely, for a tail angle of attack greater and less than the stalling angle. On the basis of the tests conducted and the results of foreign investigators, a general analysis is given of the nature of the forced vibrations, the possible load limits on the tail, and the methods of elimination of buffeting. *N.A.C.A. T.M. No. 1041*, February, 1943.

Civil Aeronautics Administration

Air-Conditioning Young America. Aviation education of the American youth is discussed in a 32-page booklet. How the United States Office of Education and the Civil Aeronautics Administration are joining forces to stimulate aviation education in elementary and high schools is described. Training methods are discussed and illustrated.

Interpretation of Civil Air Regulations, Part 61.7802 and Part 61.7803, subparagraph (7). An interpretation is given of the term "properly qualified personnel," defining the expression as pilots listed in the operations specifications of a scheduled air carrier.

A subparagraph (7) has been added to Part 61.7802 referring to pilot trainees in the employment of the air carrier; this provision will terminate at the end of the war. The provision gives permission for pilot trainees to enter the pilot's compartment and occupy the jump seat available for him in the passenger cabin, but the trainee is not permitted to occupy either of the pilots' seats or manipulate any of the control while the aircraft is in scheduled air-carrier flight. *Safety Regulation Release No. 142*, January 23, 1943.

Air Traffic Rules. A manual containing procedures and phraseologies for both airport and airway traffic control are presented. This is a supplement to Part 60 of the Civil Air Regulations and does not contain emergency regulations, being devoted entirely to recommended practices in air traffic control. The subject is dealt with under sections covering light-signal procedures for airport traffic control; radiotelephone communication procedure and technique; approach control; contact flight rules; and instrument flight rules. A glossary of terms also is furnished.

Registration Regulations. The following new regulations have been issued: Part 501—Aircraft Registration Certificates; Part 503—R—Recordation of Aircraft Ownership; Part 532—Reproduction and Dissemination of Current Examination Materials.

Office of Air Transport Information

Air Transport. J. Parker Van Zandt. This report of a study on air transportation is an extract from a volume covering various phases of transportation which was released by the National Resources Planning Board. The subject is treated under sections covering the nature of air transportation, the origin and growth of air transportation, economic characteristics of scheduled air transportation, government regulation and promotion of air transportation, and transportation and national interest.

War Department

Phonograph records of the experiences of Army pilots who have flown in combat and have led bombing raids over enemy territory have been made. Four of these records were made at an Army air base in North Africa, recorded against a background of sounds. They include reports on the Lockheed Lightning, the Boeing Flying Fortress, the Douglas Havoc, and the North American Mitchell.

The recordings are available to prime contractors and subcontractors for each of the above types of planes through the Industrial Service Division, Bureau of Public Relations, War Department, Washington, and the type of plane should be specified in the request. It is suggested by the Department that the records be reproduced in aircraft plants for the benefit of workers.

British Information Services

The Buckling of a Long Curved Panel Under Axial Compression. D. M. A. Leggett. The object of this report is to obtain further information on the behavior of curved panels under axial loading, since the problem of flat panels may be regarded as largely solved. The problem is shown to fall naturally into two parts: the initial buckling of the panel and its subsequent behavior. The current paper is confined to the first part of the problem to obtain an accurate expression of the initial buckling stress of a slightly curved and perfectly formed panel, the two straight edges of which are either simply supported or fixed. The second part of the problem is reserved for later treatment. Two main points stand out from the results obtained. First, for a perfectly formed panel the stabilizing effect of curvature is great, and for appreciable curvature it is almost immaterial whether the edges are simply supported or fixed. Second, it is found that for appreciable curvature the approximate solutions found by S. C. Redshaw are sufficiently close to the exact solutions for all practical purposes.

It is concluded that the method of solution developed in this report is widely applicable and can be used to find the stability of slightly curved panels under combined shear and compression or tension. On the basis of this report and the work of the writer and R. P. N. Jones in R.A.E. Report No. S.M.E. 3204 (unpublished), it should be possible to investigate the postbuckling behavior of an axially loaded curved panel supported along its edges. *R. & M. No. 1899.*

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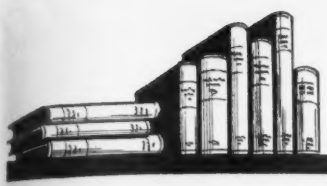

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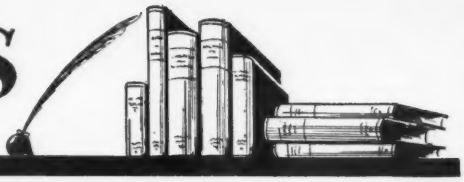

Early American Aeronautics

Hitherto, the people of the United States have been content to leave in darkness the nation's aeronautical history before the epic achievement of the Wright Brothers. Many knew hazily that Dr. Jeffries had flown across the English Channel in 1785 and that Benjamin Franklin had made a classic remark about balloons. They had seen pictures of balloons being used in the Civil War, but apart from these events little has been known and still less written.

The collection of early American books and pamphlets on aeronautics of the nineteenth century in the Archives of the Institute of the Aeronautical Sciences aroused Mr. Milbank's interest, and his excellently documented history is the result.

The early balloonists deserve a greater reward than oblivion. By their daring and perseverance they convinced the public that the air was navigable if only power were available. They made historic flights that should be remembered. Mr. Milbank has not tried to glamorize their achievements, but he has been scholarly in his treatment of their records.

Equally interesting will be the surprising fact that hundreds of scientists, inventors, promoters, and plain cranks were bending their efforts to achieve mechanical flight. Citizen Genêt in Albany in 1825 designed a dirigible airship with *living* horse power. In 1865 Mortimer Nelson patented a helicopter that is strikingly like those of today. He also incorporated the idea of the internal-combustion engine, aluminum, and a fuel mixture that he called "Carbo-Sulph-Ethal." Stranger than these, because it actually flew, was the first American dirigible airship built by Dr. Solomon Andrews of Perth Amboy. It flew from its own airport on Broome Street, New York, to Astoria, the first directed airship flight in this country.

All the pioneer investigators of the possibilities of air navigation pass in review, with heavier-than-air always just ahead. The background of scientific investigation was much larger than supposed. The art had reached a point where it presented a challenge to the young men from Dayton to add the necessary qualities to achieve practical, powered, controllable flight by man.

Books reviewed in this section may be borrowed without charge from The Paul Kollsman Library, Institute of the Aeronautical Sciences, 1505 RCA Building West, 30 Rockefeller Plaza, New York, N. Y.

England, France, Italy, and Germany all have exhaustive histories of their achievements in aeronautics. Mr. Milbank has laid a broad foundation for future investigation. It should arouse pride in the great record of early American aeronautics.

The First Century of Flight in America, by Jeremiah Milbank, Jr.; Princeton University Press, Princeton, N.J., 1943; 248 pages, $2.75.

Proponent of Air Power

No biography could be more timely than that of this leading American proponent of air power. Douhet in Italy, Lord Trenchard in England, and Mitchell in the United States will always be regarded as the far-seeing prophets of the air era in warfare. Mr. Levine has written a scholarly evaluation of the man who has not yet been honored properly in this country.

The ability of "Billy" Mitchell to make enemies in high places was so pronounced that attempts to place him in the Hall of Fame by some appropriate recognition have been thwarted by influential government officials. Possibly this book, which relates so clearly and convincingly the achievements of the great spark plug of our air power plant, may revive the proposals.

Many will find much that is new about Mitchell's career, since the author carefully gives a background of his boyhood and home life. It will be immediately evident that long research and access to hitherto unpublished records were the basis of the biography.

Some may regard the book as written completely from the Mitchell point of view and therefore as not an entirely unbiased study of the man. This was inevitable at the time, and fortunately it was done by an experienced writer who knew how to keep within the bounds of reliability.

This book, with the new translation of Douhet recently published, Mr. Milbank's *The First Century of Flight in America,* and Fred Kelly's authoritative history of the Wright Brothers will make 1943 an outstanding year for the publication of distinguished historical studies. Mr. Levine deserves great praise for the completeness as well as the restraint of the book, which will be welcomed alike by General Mitchell's many friends and by the public.

Mitchell: Pioneer of Air Power, by Isaac Don Levine; Duell, Sloane and Pearce, New York, 1943; 420 pages, $3.50.

Plea for Air Attack

No book since the Seversky and Ziff epics has offered such possibilities of controversy as the frank attack on the military airplanes of the United States and our air policy in Europe. A correspondent of *Time* who was in London during the most severe air raids gives what is evidently the English opinion of our airplanes. The book also is a plea that the R.A.F. be given sufficient equipment to enable it to bomb Germany and prepare for an invasion in 1943. The author opposes the day bombing plans of our Air Forces and urges that dampers be installed on the exhausts of the engines of our Flying Fortresses so that they will be suitable for night bombing. He would subordinate the African and China fronts to aid to the British.

Probably no book that has yet appeared gives such a detailed account of the bombing of Britain, France, Germany, and Italy. The thesis that bombing can prepare the way for ground

Erratum

In the review of *Superchargers for Aviation,* by Sanford A. Moss, in the February issue of the AERONAUTICAL ENGINEERING REVIEW, it was stated that much of the text originally was published in *Aviation.* The correct publication should have been *Aeronautics.*

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troops is carried throughout the book. But the most irritating part of the book will be the criticism of our military airplanes and the extravagant praise for English types, particularly the bombers.

The last chapter gives a description of the Luftwaffe, its organization, commanders, and strategies, which is probably the most detailed yet to appear in a book. Sketches of the German leaders are interesting, since they show what each of our air force commanders will have to meet on the German fronts.

The Air Offensive Against Germany, by Allan A. Michie; Henry Holt and Company, New York, 1943; 176 pages, $2.00.

Instrument Handbook

Precision aircraft instruments used by air navigators are described in this pocket-size book, one of the series of "Observer's Books." Because it is impossible to cover the whole field of aircraft instruments in a book of this size, the author pays particular attention to modern instruments. He discusses the earth-inductor compass, cathode-ray compass, sun compass, astrocompass, static gyrocompass, north-seeking gyrocompass, telecompass, and gyromagnetic compass. The advantages and limitations of the different types are outlined. In the latter part of the book, technical features of the altimeter, air-speed indicator, rate-of-climb indicator, and other instruments are discussed and basic principles are set forth. The final chapter is devoted to the drift recorder and the air thermometer.

The Observer's Book on Aircraft Instruments, by W. J. D. Allan; Chemical Publishing Company, Brooklyn, N.Y., 1942; 102 pages, $1.50.

Conversational Spanish for Airmen

Written for the purpose of providing officers and trainees of the Army Air Forces with a conversational knowledge of Spanish, this book is a more advanced text for students who have had some basic training in Spanish. It is intended to familiarize the student with the minimum technical vocabulary pertaining to the armed forces of the United States and also help him acquire a keener appreciation of the republics of Latin America. Supplementary material includes a vocabulary, technical expressions, facts and figures of South American countries, and a list of proper names.

Conversacion, by S. Lipp and H. V. Besso; Hastings House, New York, 1942; 294 pages, $1.50.

The Polish Squadron

The story of the heroic Polish Fighter Squadron that has fought with the R.A.F. is told by a compatriot with natural pride. This squadron destroyed 126 enemy airplanes in the Battle of Britain. The sole interest in life of these pilots is to kill Germans in revenge for the treatment of their homeland.

This book introduces many of the pilots to the reader by telling of their exploits and their character. It is a tribute to the valor, tenacity, and efficiency of the Polish airmen.

Squadron 303, by Arkady Fiedler; Roy, Publishers, New York, 1943; 182 pages, $2.00.

Naval Aviation

As Rear Admiral McCain writes in a foreword, the book is "an excellent job in portraying the current status of Naval Aviation." The methods of training pilots, navigators, bombardiers, radio operators, and mechanics are all described, as well as the constant development of naval aircraft. The emphasis of the book is on the men who fly, how they live, and what they do.

The evaluation of the role of the aircraft carrier is of special interest, since the author discusses the pros and cons of the controversy as to size, employment, and future of this essential naval ship. He believes that in the future there will be four classes of carriers: the large fleet carrier proper, like the "Lexington" or "Essex"; the smaller type, developed from a cruiser hull, like the "Independence"; the escort carrier like the "Long Island," built on a merchant hull; and the seaplane tender that carries seaplanes and flying boats. The characteristics of each class are briefly outlined.

The author's general conclusion is that no ship can survive the crushing force of air attack but that air attack cannot always be delivered.

The Navy Has Wings, by Fletcher Pratt; Harper & Brothers, New York, 1943; 224 pages, $2.75.

Course in Blueprint Reading

A course on the reading of aircraft blueprints comprises a collection of bound and loose blueprints and a book of instructions and questions. A feature is that these blueprints are typical of modern airplanes. There are some of the major units of the plane and forty consecutive ones of parts. Four large blueprints, in a pocket in the back of the book, combine detail parts into subassemblies typical of those in use in the production of airplanes. Another one of an isometric drawing designates the location of the detail parts and subassemblies in the complete airplane, enabling the student to visualize readily the placement of each part within the plane. The instruction and question manual contains 80 pages on the fundamentals of blueprint reading.

Reading Aircraft Blueprints, by Francis L. Goff and Lloyd R. Novak; McKnight & McKnight, Bloomington, Ill., 1943; $2.00.

Soldiers from the Sky

This book deals with the employment of air-borne troops, clarifying the organizational and tactical problems created by a new element in warfare. It offers a study of their attacking power and their connection with air forces.

The first part of the book describes the historical development of the airborne idea, tracing the practical effects of its application in the Spanish Civil War and in different theaters of the present war through the Battle of Crete. Subsequent chapters treat of the composition, duties, and tactics of air-borne divisions. Problems of landing and ground fighting, as well as defensive measures for countering paratroop attacks, are considered. Comprehension of the text is aided by numerous charts and graphic representations of paratroop tactics.

Paratroops, by Major F. O. Miksche; Random House, New York, 1943; 263 pages, $2.50.

Avigation

Scientific principles of aircraft navigation are given in nontechnical language. The principles of gyroscopic instruments, the radio compass, and celestial navigation are set forth. Other chapters describe the use of maps and charts in flying, the different navigation instruments and how they are used, plotting a course, the weather and its effect on flying, and the training of pilots and navigators. There is also a chapter on what boys can do before they reach high-school age to prepare themselves for a career in air navigation. In addition to drawings, maps, diagrams, and photographs, the book contains an official navigation chart of the section of the United States around Seattle and Tacoma.

Air Navigation, by Herbert S. Zim; Harcourt, Brace and Company, New York, 1943; 324 pages, $3.00.

Compass Compensation

The author presents a book devoted entirely to the subject of compass compensation. It is intended for use as a textbook for academies and colleges

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Radio, of course, could not accomplish these things were it not for the invention and development of electronic vacuum tubes. Vacuum tubes, of various types, are the heart and soul of radio and every other achievement in the so called science of electronics. Think, then how much credit, for the conquest of the air, is due to the vacuum tubes in the ground stations and blind landing systems now in service. Remember this, too: Eimac tubes are in the important sockets of the ground stations of every major airline.

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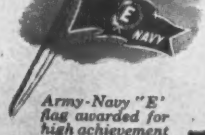

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and as a reference manual for navigating officers. The first part is devoted to the physical representation of the theory of compass compensation. In the second part the application of the theory to practice is presented. In an appendix are sections covering the development of the general equation, the determination of parameters and the development of healing equations. The appendix also contains miscellaneous formulas and a table of trigonometric functions.

A Treatise on Compass Compensation, by L. V. Kielhorn; D. Van Nostrand Company, Inc., New York, 1942; 195 pages, $2.25.

Carburetor Operation

A description is given of the design, principles of operation and maintenance of the Stromberg injection carburetor, stated to be one of the latest types of carburetor used on Allied airplanes.

In opening paragraphs the functions of the carburetor are outlined and fuel injection in general is discussed. Known types of fuel injection are defined as timed injection into the engine cylinder head, timed or continuous injection into the induction manifold, and continuous metered spray into the supercharger entry. The metered-spray method is the subject of the book.

After giving three basic troubles with the conventional float carburetor—metering instability during aerobatics, icing of the throttle and venturis, and possible vapor formation with consequent metering disturbance—cylinder injection versus manifold injection is discussed and the advantages of the Stromberg system are set forth. With the aid of diagrams and illustrations, the principles on which the Stromberg system of pressure carburetion operate are outlined in considerable detail. The following sections of the book deal with pressure carburetor production arrangements; types, sizes and the general operation of the pressure carburetor; running adjustments; fault-finding; and overhaul.

The Stromberg Injection Carburettor, by Charles H. Fisher; Chemical Publishing Company, Inc., New York, 1943; 112 pages, $2.50.

Introductory Meteorology

Presented as an introduction to meteorology, this book is designed primarily for the student pilot but should be useful to laymen interested in acquiring a basic knowledge of the subject. Opening chapters deal with the atmosphere, temperature, water vapor in the atmosphere, and barometric pressure. The author continues with a discussion of vertical movements of the atmosphere, temperature changes in the air due to ascent, and atmospheric turbulence. Other chapters cover clouds, visibility, pressure systems in the westerlies, air masses, the structure and movement of depressions and fronts, and anticyclones. The course is concluded with a chapter on the synoptic chart and forecasting.

Weather, by W. G. Kendrew; Oxford University Press, New York, 1943; 96 pages, $1.00.

Explosives Manual

The author presents a manual for scientific and technical workers in the field of explosives and war chemicals and for students specializing in these subjects. Information on the composition, properties and uses of the more important explosives, explosive mixtures, and modifying and adding agents is given, with particular attention to those that are being used at present and those that have been used as far back as World War I. Because military pyrotechnics are closely connected with the field of military explosives, the more important chemicals that are finding application as pyrotechnics, incendiaries, and smoke-producing agents are included in the text. In addition, chemical warfare agents that are considered to be generally effective and suitable for application under combat conditions are listed.

Manual of Explosives, Military Pyrotechnics, and Chemical Warfare Agents, by Jules Bebie; The Macmillan Company, New York, 1943; 171 pages, $2.00.

Book Notes

Primer of Navigation, by George W. Mixter; D. Van Nostrand Company, Inc., New York, 1942; 337 pages, $4.00.

Ninth printing of a textbook on surface navigation. While the extensive survey of navigational methods and principles is designed mainly for the instruction of neophytes, material of value to experienced navigators is included. Complete tables and work forms are given.

Resource Units for Teachers in Pre-Flight Aeronautics, prepared by the Workshop in Pre-Flight Aeronautics, University of Minnesota; Burgess Publishing Company, Minneapolis, Minn., 1942; 78 pages, $1.25.

The resource material in this book was compiled by a group of specialists and teachers for the purpose of assisting teachers dealing with the problems of developing preaviation courses for high-school students. Sections of the book cover objectives for preflight aeronautics, social studies, aspects of aviation, aerodynamics, engines, navigation, and meteorology. There is an appendix covering three demonstrations in aerodynamics, a demonstration model airplane, and multiple-choice test questions on aerodynamics, meteorology, and navigation.

A Short History of Navigation, by W. J. V. Branch and Capt. E. Brook-William; Weems System of Navigation, Maryland, 1942; 91 pages.

In this book the development of navigation is not related chronologically but is traced from three sources: scientific instrument development, mathematics, and astronomy. The contributions of each of these sciences to the art of navigation are outlined, and the history concludes with data on sailings, maps, charts, and celestial navigation.

Pipe and Tube Bending, by K. W. Knutson; Cornell Maritime Press, New York, 1943; 29 pages, $1.00.

The author presents a simplified tabular method of calculations for bending pipe and tubing. The booklet contains original tables for the rapid calculation of any bend with a minimum error. With the centerline and "gain" values furnished, bends may be finished without taking the work from the machine or using full-scale drawings. Explanations and several drawings aid the reader in understanding the method.

Aeronautical Training, by Charles A. Zweng; Pan American Navigation Service, North Hollywood, Calif., 1942; 235 pages, $3.00.

The 1942 edition of this instruction book was made necessary by the many changes in the civil air regulations. Enlargement of the text has been made in order to include new amendments and changes in the regulations, to include new and additional matter on meteorology caused by changes in the teletype code and weather broadcasts, and to add new matter covering the more rigid requirements for private and commercial pilot examinations.

This book is especially adapted for the use of colleges and schools giving flight and ground-school training under the C.A.A. training program. It is also recommended by the author for study in preparation for written examinations. It is suggested that

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students taking private or commercial pilot examinations use the Pilot's Aircraft Plotter (Department of Commerce type) in plotting navigation problems.

The first five sections of the book cover aircraft and the theory of flight, aircraft engines, navigation, meteorology, and air-traffic rules. Remaining sections are devoted to general examination questions and the examinations for commercial and private pilots. An appendix includes amendments to the civil air regulations and diagrams of fuel and electrical circuits and engine components.

Plane Crazy, by Dorothy Rood Stewart; Row, Peterson & Company, Evanston, Ill., 1942; 95 pages, $0.50.

A comedy in three acts which dramatizes the urge of Jimmy Haleon, who wants to learn to fly. He overcomes his father's opposition by combined efforts of his friends at the airport. The play was first presented at Geneva College on March 19, 1942.

It is suitable for college and school theatricals. The booklet gives complete instructions for staging, costuming, and characterizations.

American Aviation Directory; American Aviation Associates, Inc., Washington, D.C., 1942; 344 pages, $5.00.

The Fall-Winter 1942 edition of the *American Aviation Directory* listing aviation officials and companies has been issued. This directory is divided into sections covering air transportation, parent and holding companies, aircraft manufacturers, accessories, school and local operators, aviation organizations and associations, Government agencies and commissions, and individuals. Wartime security has necessitated the omission of certain information normally contained in a book of this type, but this should not detract from the general usefulness of the volume.

Naval Warfare, by Comdr. John Creswell; Chemical Publishing Company, Inc., Brooklyn, N.Y., 1942; 302 pages, $4.00.

This is the second revised edition of a survey of the activities of the British Navy in wartime. The author has added a new chapter on "Geography and Strategy" and postscripts to some other chapters to bring them up to contemporary conditions, but evidently even these were written before the aircraft carrier came into such prominent use. Hardly any mention is made of this essential warship. Historically, junior naval officers will find the book of value, but the great change made by aircraft in British naval operations will probably cause the author to prepare a further revision.

Mathematics For Ready Reference, by H. M. Phillips; Frederick J. Drake & Co., Chicago, 1942; 224 pages, $2.00.

A review of mathematics, featuring applications to practical problems. Simple explanations of arithmetic, algebraic and geometric fundamentals form the main part of the text. A supplementary index provides a convenient reference guide to individual subjects.

Meteorological Observer's Handbook, 1942; British Air Ministry, Meteorological Office, London, 1942; 160 pages, 6*s.* 0*d.*

Instructions in the care and manipulation of meteorologic instruments and in the making of both instrumental and noninstrumental observations are presented in the form of a handbook. While written primarily for observers in the British Isles, the book is also suitable for use in British colonies, footnotes having been added to describe modifications in practice made necessary by differences in climate. The first part of the book contains instructions for making the observations which constitute the routine of a normal climatologic station. The second section is devoted to autographic instruments. In the last part of the book, tables are given for the use of observers.

Aircraft Recognition, by R. A. Saville-Sneath; Penguin Books, Inc., New York, 1943; 252 pages, $0.25.

A second edition of this useful book for aircraft spotters and pilots who are flying in combat areas. This revision contains silhouettes and descriptions of about 30 additional types of airplanes. Material dealing with points of recognition has been revised in accordance with recent battle experiences and advances in the theory of aircraft spotting. Many photographs and considerable supplemental material have also been added.

It is one of the most useful and inexpensive books on aircraft recognition.

How to Navigate Today, by M. R. Hart; Cornell Maritime Press, New York, 1943; 84 pages, $1.50.

This book gives the essentials of navigation based on the standard method used by the U.S. Navy. The method incorporates the use of modern navigation tables, which, the author states, leave little to do but look up the answers.

The subject is approached by a description of the principles involved, instead of beginning with astronomic details. The author then takes up specific problems, discussing navigation by the sun, meridian altitude, identifying the stars, and aerial navigation. Based on his own experience, the author tells what star to "shoot," points out common mistakes, and explains how to use the H.O. 214, H.O. 208 (Dreisonstok), and the H.O. 211 (Ageton). Problems and diagrams are given to aid the student.

If Bombs Fall! by George Baehr, W. W. Bauer, D. Lois Burnett, Arthur E. Hollenbeck, Amy Klose, H. W. Vollmer, Harold M. Walton, and others; Review and Herald Publishing Association, Washington, D.C., 1942; 96 pages, $0.25.

This book, telling civilians what to do in the event of air raids, consists of individual chapters written by several medical doctors, nurses, and others, each on a specific subject. A description is given of the proper way to black out houses and of how to see in a black-out. First-aid procedure is covered. Other sections deal with how to guard the home front, the care of the sick, and how to quiet the nerves.

How to Get a Job in the Aircraft Industry, by Berne Wolfe; Wallach Publications, Inc., Mount Vernon, N.Y., 1943; 111 pages, $1.00.

Practical advice on how to obtain employment in the aircraft industry is

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presented in a manual on the subject. The text is directed toward providing the reader with a knowledge of how to find his proper place in the industry. In addition to a detailed description of the many jobs involved in the production of aircraft, the book brings together scattered information of importance to the job seeker, including the names and addresses of the principal aircraft manufacturers, samples of aptitude tests, tables of wage scales, and lists of free training centers and the courses each center provides.

Tables of Data on Chemical Compositions, Physical and Mechanical Properties of Wrought Corrosion-Resisting and Heat-Resisting Chromium and Chromium-Nickel Steels, prepared by Russell Franks and Francis L. LaQue; American Society for Testing Materials, Philadelphia, Pa., 1943; 43 pages, $1.25.

New tables of data on chemical compositions, physical and mechanical properties of wrought corrosion-resisting and heat-resisting chromium and chromium-nickel steels have recently been issued by the American Society for Testing Materials.

The first part of the booklet pertains to wrought chromium steels, while the second part covers wrought chromium-nickel steels up to 25 per cent chromium, 20 per cent nickel. In all there are 21 detailed tables and 26 charts and curves covering important data such as chemical composition, physical properties, forging and heat-treating practices, and mechanical properties of steels. There is information on creep characteristics and short-time tensile properties. This publication is the third in the series on stainless steels issued through the work of the Society, the first two having been published in 1924 and in 1930.

Air Ministry Room 28, by Gilbert Frankau; E. P. Dutton & Company, Inc., New York, 1942; 383 pages, $1.00.

A mystery novel which centers around the murder of an Air Commodore in the Air Ministry in London. It does not present a flattering view of the R.A.F. officers or the civil servants of the British Government, but it does give an interesting picture of some of the workings of British officialdom. There is a wide use of slang that will not be comprehensible to American readers. Romance, adventure, and life in London under war conditions add interest to the story.

Industrial Radiology, by Ancel St. John and Herbert R. Isenburger; John Wiley & Sons, Inc., New York, 1943; 298 pages, $4.00.

This is a second edition of a book originally titled *Industrial Radiography*. The title has been changed because the visual inspection of materials has come into use, and this factor is discussed. Radiology is defined as including radiography and fluoroscopy. Practical aspects of industrial radiology are presented in language that can be understood by the student and layman.

The book is useful to engineers who wish to obtain a knowledge of the basic theories involved. The revised edition contains new material on equipment and accessories, and a master index has been added to make all the applications and possibilities of industrial radiology available for reference without unduly enlarging the text.

Engine Principles, by James W. Etchison; Airlines War Training Institute, Washington, D.C., 1943; 224 pages.

A book on aircraft-engine principles is presented for flight and ground crews and their instructors. The book is not intended for home study but for use in the classroom. It is divided into sections, each of which represents about one hour of lecture. Example problems for the student are furnished at the end of each section.

Flight to England, by I. A. R. Wylie; Random House, New York, 1943; 192 pages, $1.75.

Into her account of a visit to England, made at the invitation of the British authorities, the author has woven what she calls her uncompromising analysis of the things and people she saw. The events of this visit to England at war are viewed from a longer-range standpoint than the day-to-day news reports. Instead of a succession of lightning flashes, to which such reports are likened, the author has endeavored to shed a clear, steady light on the wartime activities of the English people. The book deals less with passing events than with the more constant factors of heart and mind.

Sally Wins Her Wings, by Margaret Irwin Simmons; Thomas Y. Crowell Company, New York, 1943; 258 pages, $2.00.

The story of a girl who learns to fly by scrimping on her living expenses while employed in various occupations. She takes her commercial license and then becomes an instructor. After many flying experiences in which romance has its part, she finally joins the women pilots who are flying for the R.A.F. in England.

The struggle of the heroine and her determination to progress in her chosen work will give a picture of the exhilaration and fascination of flying, which are motivating factors in the growth of the industry.

Warplanes of the World; Dell Publishing Company, Inc., New York, 1943; 98 pages $0.25.

This annual publication contains photographs and brief descriptive matter on the service aircraft of the principal nations of the war. There are sections on the equipment used by the air forces of the United States, Great Britain, Germany, Italy, Japan, and Russia. Each of the leading types of aircraft is illustrated, and brief paragraphs give the characteristics of the plane.

There are construction drawings of certain American, British, and German aircraft taken from *The Aeroplane* and *Flight*. Each airplane type is indexed.

How to Identify Aircraft, by Squadron Leader G. E. Wilson; Wm. Collins Sons & Co., Canada Ltd., Toronto, Canada, 1942; 159 pages, $1.25.

This book covers the recognition of 68 types of planes....24 British, 19 American, and 25 German. Preceded by advice on methods of identification and study, drawings of each aircraft are shown, their features are noted, and résumés of their histories are given. Special groups of drawings illustrate the fins and rudders of the Bristol, Hawker, and Curtiss-Wright airplanes, as well as the characteristics of the Short, Heinkel, Blohm und Voss, Focke-Wulf, and Dornier-Werke planes. Similar sketches show the recognition points of other military aircraft.

Dictionary of Aeronautical Terms; Director of Intelligence Service, Washington, D.C., 1942; 484 pages, $0.35.

This dictionary of aeronautical terms has been reproduced under the supervision of the Director of Intelligence Service, A.A.F., from the original in the W. A. M. Burden Library. It contains aeronautical terms in five languages—Japanese, Chinese, English, French, and German—and is intended as a ready reference manual.

Stratosphere Flying Including Navigation for Emergencies, by Capt. E. Cecil Evans Fox; The Aeronautical Institute of Canada, Toronto, Ontario, 1942; 64 pages, $1.00.

Principles of flight are given in a volume that is designed to be combined with a second volume presenting a further discussion of the subject. The author presents an outline of aeronautics in a form that should be especially useful to pilots, air travelers, and cadets. Most of the text was originally published in the *Air Force Review*.

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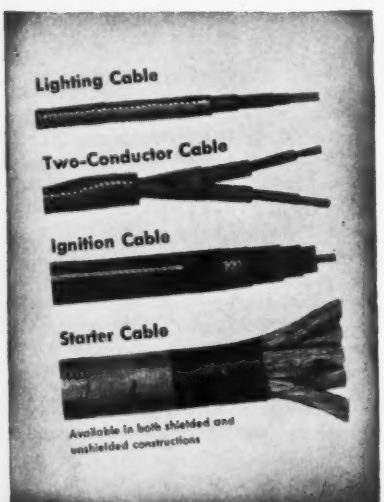

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What You Can Do in Civilian Defense, edited by Franklin J. Meine and Harold Lee Hitchens; Consolidated Book Publishers, Inc., Chicago, 1943; 64 pages, $0.15.

This handbook surveys the various civilian volunteer activities, describing their purpose and operation. Its chapters are devoted to the following subjects: mental armament, civilian protection program, the civilian's chance to share in the work, the Citizens Defense Corps and its control system, and air-raid precautions.

Transportation in Wartime and the United Nations, edited by John A. Krout; The Academy of Political Science, Columbia University, New York, 1943; 111 pages, $2.50.

First issue for 1943 of the Proceedings of the Academy of Political Science, this booklet is composed of the addresses and papers presented at the annual meeting on November 10, 1942. With the subject matter divided into three parts, the first—the War of Distances—deals with wartime transportation by railroads, ships, and airplanes. Discussions reported in the second part concern the movement and supply of the armed forces, and those in the third part refer to various phases of the conduct of war and peace by the United Nations.

His Majesty's Ships; British Information Services, New York, 1942; 95 pages.

A compendium of the ships in the Royal Navy, Royal Canadian Navy, Royal Australian Navy, Royal New Zealand Navy, South Africa Naval Forces, and the Royal Indian Navy. The extent of the British navies in their numbers of ships and diversity of types is reviewed. It is accompanied by illustrations, specifications are given on battleships, aircraft carriers, cruisers, minelayers, destroyers, submarines, sloops, and other naval craft.

A German Ace Tells Why, by Leonhard Guenther; Sci-Art Publishers, Cambridge, Mass., 1941; 82 pages, $1.00.

Third and revised edition of a book that is purported to contain authentic entries from the diary of a high-ranking Luftwaffe officer. It reveals the political attitude of an educated German during the period 1915–1939. The aftermaths of the first war, the genesis of Hitlerism, the growth of the National-Socialist idea, and the Nazification of German youth are briefly presented from a specialized point of view.

Magnesium and Its Alloys, by H. S. Hirst and A. B. Guise; National Fire Protection Association, Boston, Mass., 1942; 19 pages, $0.20.

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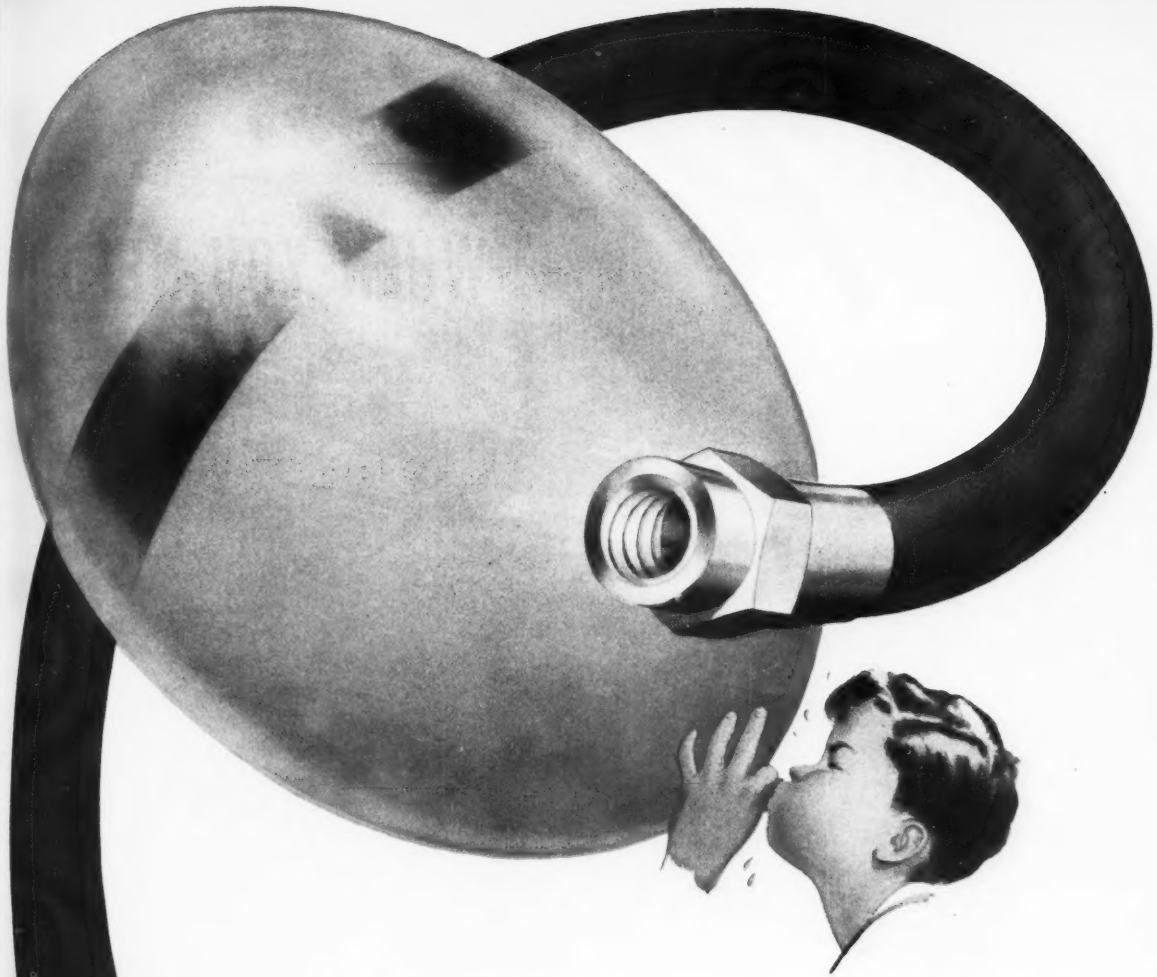

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*Gears designed and manufactured by Pacific Gear Works, Los Angeles, Calif.

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A revised edition of a pamphlet dealing with fire hazards in the use of magnesium and its alloys. In addition to outlining the characteristics of the material, the booklet covers fire and explosion tests, storage and handling, annealing and other heating processes, and the use of fire extinguishers.

Mathematics Dictionary, by Glenn James and Robert C. James; The Digest Press, Van Nuys, Calif., 1943; 320 pages, $3.00.

A dictionary giving the meaning of basic mathematical words and phrases and covering terms from arithmetic through the calculus is presented. Technical terms commonly used in the applications of these subjects are also included. An appendix contains tables of denominate numbers, compound interest, American experience mortality, logarithms of numbers, differentiation formulas, and integrals. The Greek alphabet is shown and mathematical symbols are listed.

Sanabria's Airpost Catalogue; Nicolas Sanabria, Inc., New York, 1943; 930 pages, $3.00.

The 1943 edition of a standard book for aerophilatelists. A total of 7,475 officially issued government airpost stamps is listed. The air stamps shown are divided into two main classifications: Government and Semiofficial. In the Government category are included all stamps issued by the regularly constituted authorities of the country covered; the term "semiofficial" is applied to all stamps that do not come under the Government classification but have some degree of Government sanction or approval. Known examples of aero postal stationery air stamp specimens are recorded.

First Aid and Air Raid Precautions; Authentic Publications Co., New York, 1942; 31 pages, $0.10.

A pamphlet containing information on how to protect the home against air raids, how to behave during air raids, and how to distinguish between Allied and Axis warplanes. Enemy bombs and their effects are described and there is also a first-aid guide.

Welding and Brazing Alcoa Aluminum; Aluminum Company of America, Pittsburgh, Pa., 1942; 100 pages.

This booklet is divided into two sections: one covers the gas welding, arc welding, and electric resistance welding of Alcoa aluminum; the other furnishes information on the brazing of this material. To illustrate proper flame adjustment, colored photographs of welding flames are presented. Other illustrations show welding operations and equipment.

Library Accessions

War Department Manuals. The following recent War Department manuals have been received. In most cases, copies may be obtained from the Superintendent of Documents, Washington, D.C., at the prices noted, where such information is given (TM, Technical Manuals; FM, Field Manuals):

TM 1-206 Celestial Air Navigation—$0.35.

TM 1-212 Basic Flying.

TM 1-215 Advanced Flying (Single Engine).

TM 1-216 Advanced Flying (Multi-Engine).

TM 1-240 Arctic Manual—$0.15.

TM 1-305 Theory of Ballooning—$0.10.

TM 1-405 Aircraft Engines.

TM 1-408 Aircraft Engine Operation and Test.

TM 1-410 Airplane Structures—$0.20.

TM 1-411 Airplane Hydraulic Systems and Miscellaneous Equipment—$0.15.

TM 1-447 Instrument Trainer Maintenance—$0.40.

TM 1-460 Radiotelephone Procedure Army Air Forces—$0.15.

TM 1-650 Maintenance Policies, Publications and Forms—$0.20.

TM 1-1000 Vocational Teaching—$0.15.

TM 4-325 Coast Artillery Gunners' Instruction, Antiaircraft Gun, Automatic Weapon, and Headquarters Batteries, First and Second Class Gunners.

TM 4-330 Coast Artillery Gunners' Instruction, Antiaircraft Searchlight Batteries, First and Second Class Gunners.

TM 4-335 Coast Artillery Gunners' Instruction Antiaircraft Artillery Expert Gunners.

TM 5-240 Aerial Phototopography.

TM 5-268 Repair of Fishnets.

TM 5-269 Materials for Protective Concealment.

TM 5-310 Military Protective Construction.

TM 8-285 Treatment of Casualties from Chemical Agents.

TM 9-227 20-MM Aircraft Gun Matériel M1 and Ms—$0.10.

TM 9-760 Bomb Trailer M5—$0.10.

TM 9-1227 Ordnance Maintenance 20-MM Automatic Gun M1 and 20-MM Aircraft Automatic Gun AN-M2.

TM 9-1360 Ordnance Maintenance 3-Inch Antiaircraft Gun Matériel, M2A2, M2A1, M1A2, M1A1, T1A2, and T1A1—$0.10.

TM 9-1600 Ordnance Maintenance Direct-Fire Telescopes for 3-Inch and 90-MM Antiaircraft Guns—$0.10.

TM 9-1662 Ordnance Maintenance Binaural Training Instruments, M1 and M2—$0.10.

TM 9-1900 Ammunition, General.

TM 9-2662 Instruction Guide Binaural Training Instrument M2.

TM 30-252 Portuguese Phrase Book.

TM 30-256 Icelandic Phrase Book—$0.10.

FM 1-50 Army Air Forces Field Manual.

FM 1-60 Air Corps Field Manual, Reviews and Inspections—$0.10.

FM 3-5 Chemical Warfare Service Field Manual, Tactics of Chemical Warfare—$0.10.

FM 4-105 Coast Artillery Field Manual, Antiaircraft Artillery Organization and Tactics—$0.35.

FM 4-111 Coast Artillery Field Manual, Antiaircraft Artillery Position Finding and Control Antiaircraft Searchlights—$0.10.

FM 4-112 Coast Artillery Field Manual, Antiaircraft Artillery Gunnery, Fire Control, Position Finding, and Horizontal Fire, Antiaircraft Automatic Weapons (Case 1 Firing)—$0.20.

FM 4-115 Coast Artillery Field Manual, Antiaircraft Artillery Operation of Matériel and Employment of Personnel, Antiaircraft Searchlight Units—$0.05.

FM 4-120 Coast Artillery Field Manual, Antiaircraft Artillery Formations, Inspections, Service, and Care of Matériel.

FM 4-125 Coast Artillery Field Manual, Antiaircraft Artillery Service of the Piece 3-Inch Antiaircraft Gun—$0.05.

FM 4-130 Coast Artillery Field Manual, Antiaircraft Artillery Service of the Piece 105-MM Antiaircraft Gun—$0.15.

FM 4-135 Coast Artillery Field Manual, Antiaircraft Artillery Marksmanship and Service of the Piece Antiaircraft Machine Gun—$0.20.

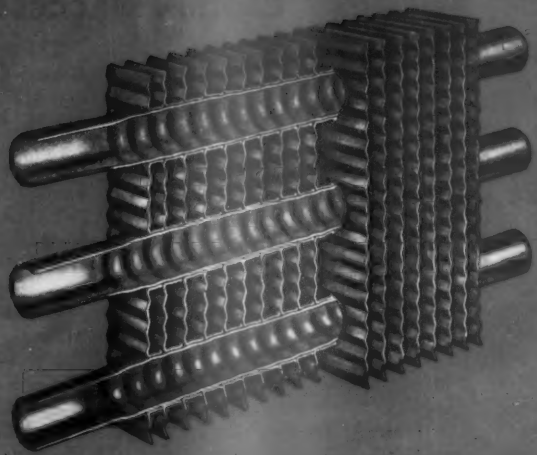
FM 4-140 Coast Artillery Field Manual, Antiaircraft Artillery Service of the Piece 37-MM Antiaircraft Gun (Case 1 Firing)—$0.15.

FM 4-141 Coast Artillery Field Manual, Antiaircraft Artillery Service of the Piece 40-MM Antiaircraft Gun—$0.25.

FM 12-105 Adjutant General's Field Manual, The Army Postal Service.

FM 21-26 Basic Field Manual, Advanced Map and Aerial Photograph Reading.

FM 31-15 Basic Field Manual, Operations in Snow and Extreme Cold—$0.20.



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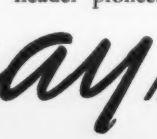

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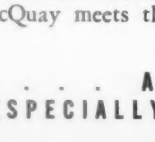

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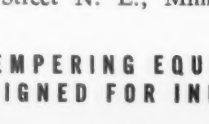

VENTILATION HEATERS NAVY TYPE

AIRCRAFT HEATING SECTION

Source Material

For the information of readers, the following lists the periodicals, house organs, and other publications regularly received and reviewed.

The prices listed are for yearly subscriptions to recipients in the United States. Subscription prices to house organs are in many cases not available but may be obtained directly from the offices of the organization.

Aero Digest, 515 Madison Ave., New York City, $5.00.

Aero News Letter, Aero Insurance Underwriters, 111 John St., New York City.

Aerodrome Abstracts, compiled by the Department of Scientific and Industrial Research, and issued in collaboration with the Air Ministry, The Institution of Civil Engineers, St. George St., Westminster, London, S.W.1.

Aeronautica, Avenida de Mayo 1370, Buenos Aires, Argentina, Pesos 4.50.

Aeronautica Argentina, Cassilla de Correo 1897, Buenos Aires, Argentina, Pesos 8.00.

Aeronautics, Tower House, Southampton St., London, W.C.2, 27*s.*

Aeronautics (Quarterly), 37 W. 45th St., New York City, $1.00.

The Aeroplane, Bowling Green Lane, London, E.C.1, 61*s.*

The Aeroplane Spotter, Bowling Green Lane, London, E.C.1, 8*s.* 8*d.*

Air Facts, 30 Rockefeller Plaza, New York City, $3.00.

Air Force, U.S. Army Air Forces, 101 Park Ave., New York City.

Air Force Review, 31 Willcocks St., Toronto, Canada, $3.00.

The Air Line Mechanic, 6250 S. Kedzie Ave., Chicago, Ill.

The Air Line Pilot, 3145 W. 63rd St., Chicago, Ill.

Air Mail Magazine, Newport, Monmouthshire, England, 5*s.*

Air News, 545 5th Ave., New York City, $1.50.

Air Progress, 79 7th Ave., New York City, $1.00.

Air Tech, 545 5th Ave., New York City, $2.50.

Air Trails, 79 7th Ave., New York City, $2.00.

Air Transportation, 10 Bridge St., New York City, $5.00.

Air-Age, 160 W. Broadway, New York City, $0.90.

Aircraft, 62 Flinders St., Melbourne, C.1, Australia, 16*s.*

Aircraft Engineering, 12 Bloomsbury Sq., London, W.C.1, 26*s.*

Aircraft Journal, United Aircraft Corp., East Hartford, Conn.

Aircraft Production, Dorset House, Stamford St., London, S.E.1, £1 14*s.* 6*d.*

Aireports, 515 Madison Ave., New York City.

The Airesearcher, Airesearch Mfg. Co., Sepulveda Blvd., Los Angeles, Calif.

Airflow, Casey Jones School of Aeronautics, Jackson Heights, New York, and Newark, N.J.

Airlanes, 333 W. 57th St., New York City, $2.50.

Airpost Journal, Albion, Pa., $2.00.

Allisonews, Allison Division, General Motors Corporation, Indianapolis, Ind.

Aluminum News Letter, Aluminum Co. of America, Pittsburgh, Pa.

Amarillo Field Mecha News, Ewing Publishing Co., 2812 W. 6th Ave., Amarillo, Tex.

American Association for the Advancement of Science, Bulletin, Smithsonian Institution Bldg., Washington, D.C., $1.00.

American Aviation, 1317 F St., N.W., Washington, D.C., $3.00.

American Aviation Daily, 1317 F St., N.W., Washington, D.C.

American Aviation Sky-Gest, American Aviation Corp., Jamestown, N.Y.

American Import and Export Bulletin, 10 Bridge St., New York City, $5.00.

American Machinist, 330 W. 42nd St., New York City, $5.00.

The American Mercury, 570 Lexington Ave., New York City, $3.00.

American Meteorological Society, Bulletin, Milton, Mass., $3.50.

The American Pilot and Aircraftsman, 225 S. Church St., Charlotte, N.C., $2.00.

Anahuac, Talleres N. de C. A., Balbuena, D.F., Mexico, $6.00 (Mex.).

A.O.P.A. Section, Aircraft Owners & Pilots Assn., 1424 Walnut St., Philadelphia, Pa.

Army Ordnance, 705 Mills Building, Washington, D.C., $4.50.

A.S.T.M. Bulletin, American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa., $1.50.

Astronautics, 130 West 42nd St., New York City, $3.00.

Automotive and Aviation Industries, Chestnut & 56th Sts., Philadelphia, Pa., $1.00.

Automotive News, 5229 Cass Ave., Detroit, Mich., $4.00.

Automotive War Production, Automotive Council for War Production, New Center Bldg., Detroit, Mich.

Avia, Belgrano 471, Piso 3°, Buenos Aires, Argentina, $6.00 *m/n.*

Aviacão, R. Uruguiana 104, 4°, Rio de Janeiro, Brazil, *Rs.* 70$000.

Aviation, 330 W. 42nd St., New York City, $3.00.

Aviation Equipment, 1170 Broadway, New York City.

Aviation Progress in Los Angeles County, Board of Supervisors of Los Angeles County, Los Angeles, Calif.

The Aviatrix, Women's National Aeronautical Assn., Tulsa Loan Bldg., Tulsa, Okla.

Bakelite Review, Bakelite Corp., 30 E. 42nd St., New York City.

The Bee-Hive, United Aircraft Corp., East Hartford, Conn.

The Beech Log, Beech Aircraft Corp., Wichita, Kan.

Bell Laboratories Record, 463 West St., New York City, $2.00.

The Bell Ringer, Bell Aircraft Corp., 2050 Elmwood Ave., Buffalo, N.Y.

The Blade, Bladesman, Curtiss-Wright Corp., Propeller Division, Caldwell, N.J.

Boeing Contact, Boeing Plane Talk, Boeing Airplane Co., Wichita, Kan.

Boeing News, Boeing Aircraft Co., Seattle, Wash.

The Bombsight, Advanced Flying School, Army Air Forces, Kirtland Field, N.M.

Breeze American, Breeze Corporations, Inc., 41 S. 6th St., Newark, N.J.

British Airways News Letter, British Overseas Airways Corp., Airways House, London, S.W.1.

Bulletin of War Medicine, British Information Services, 30 Rockefeller Plaza, New York City, $4.50.

Caminos del Aire, Pan American Airways, Bolivar 18, México, D.F.

Canadian Air Cadet, 122 Wellington St., Ottawa Canada, $1.00.

Canadian Aviation, 481 University Ave., Toronto, 2, Canada, $2.50.

The Cessquire, Cessna Aircraft Co., Wichita, Kan.

Civil Aeronautics Journal, U.S. Government Printing Office, Washington, D.C., $0.50.

Civil Air Patrol Bulletin, Office of Civilian Defense, Washington, D.C.

Civil Air Patrol Bulletin, Wisconsin Wing 62, Civil Air Patrol, 110 E. Wisconsin Ave., Milwaukee, Wis.

Civil Air Patrol Courier, Missouri Wing 73, Civil Air Patrol, Kratz Field, St. Louis, Mo.

Colliers, The Crowell-Collier Publishing Co., Springfield, O., $3.00.

Commercial Aviation, 919 Tramways Bldg., Montreal, Canada, $3.00.

The Consolidated Eagle, Consolidated Aircraft Corp., Fort Worth, Tex.

Construction Glues, I. F. Laucks, Inc., 911 Western Ave., Seattle, Wash.

Contact, Air Lines Terminal Bldg., New York City, $2.00.

Culver's Going Places, Culver Aircraft Corp., 600 E. 35th St., Wichita, Kan.

Current Aviation, 400 S. Front St., Columbus, O., $0.80.

Curtiss Fly-Leaf, Curtiss-Wright Corp., Municipal Airport, Buffalo, N.Y.

Curtiss-Wright-er, Curtiss-Wright Corp., Lambert Field, St. Louis, Mo.

Diesel Power & Diesel Transportation, 192 Lexington Ave., New York City, $3.00.

Douglas Airview, Douglas Aircraft Co., Inc., Santa Monica, Calif.

The Draftsman, 171 Madison Ave., New York City, $3.00.

The Dragon, The Fafnir Bearing Co., New Britain, Conn.

The Eaton News, Eaton Mfg. Co., 739 E. 140th St., Cleveland, O.

The Edo Log, Edo Aircraft Corp., College Point, N.Y.

The Engineer, 28 Essex St., Strand, London, W.C.2, £3 3*s.*

Enid Plane Facts, Enid Army Flying School, Enid, Okla.

The Exchangite, 335 Superior St., Toledo, O., $1.00.

Fairchild Engineering News, Fairchild Aircraft Division, Fairchild Engine and Airplane Corp., Hagerstown, Md.

Fleetwings' Arrow, Fleetwings, Bristol, Pa.

Flight, Dorset House, Stamford St., London, E.C.1, £3 1*s.*

Flying Cadet, 420 Lexington Ave., New York City, $1.00.

Flying; Including Industrial Aviation, 540 N. Michigan Ave., Chicago, Ill., $3.00.

The Flying M, Menasco Mfg. Co., 805 S. San Fernando Blvd., Burbank, Calif.

The Foundation, The Engineering Society of Detroit, 100 Farnsworth Ave., Detroit, Mich.

Franklin Institute, Journal, Philadelphia, Pa., $6.00.

General Aircraft News, London Air Park, Feltham, Middlesex, England.

Globe Beam, Globe Aircraft Corp., North Side Station, Fort Worth, Tex.

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GM Folks, General Motors Corp., Detroit, Mich.

Goodrich Circle, The Goodrich Silvertown News, The B. F. Goodrich Co., Akron, O.

Great Britain, Aeronautical Research Committee, Reports and Memoranda, British Information Services, 30 Rockefeller Plaza, New York City.

Group 514 News, Civil Air Patrol Group 514, Cleveland Municipal Airport, Cleveland, O.

Heat Treating and Forging, 108 Smithfield St., Pittsburgh, Pa., $2.00.

Heath Beacon, Heath Company, Benton Harbor, Mich.

High Pressure, Walter Kidde & Co., 140 Cedar St., New York City.

Indian Aviation, 13 Ezra Mansions, P. O. Box 2361, Calcutta, India, *Rs.* 7/8.

Industrial and Engineering Chemistry, Industrial Edition, 1155 16th St., N.W., Washington, D.C. $4.00.

Institute of Transport, Journal, 15 Savoy St., London, W.C.2, 10*s.* 4*d.*

Institute of Welding, Transactions, 2, Buckingham Palace Gardens, London, S.W.2, 32*s.*

The Intava World, International Aviation Associates, Artillery House, Artillery Row, London, S.W.1.

The Intercontinent News, Intercontinent Aircraft Corp., Miami, Fla.

Interstate-ments, Interstate Aircraft and Engineering Corp., 3443 Wilshire Blvd., Los Angeles, Calif.

Jefferson Barracks Hub, Air Forces Basic Training Center, Jefferson Barracks, Mo.

Journal of Applied Mechanics, 29 W. 39th St., New York City, $5.00.

Journal of Aviation Medicine, 2642 University Ave., St. Paul, Minn., $5.00.

Journal of Research of the National Bureau of Standards, U.S. Government Printing Office, Washington, D.C., $3.50.

Journal of Scientific Instruments, The University, Reading, Berkshire, England, 33*s.*

Journal of the Aeronautical Sciences, 1505 RCA Building West, New York City, $7.00.

The Kearns Post Review, Air Forces Basic Training Center, Kearns, Utah.

Keep 'Em Flying, The Miami Herald, Miami, Fla.

The Learavian, Lear Avia, Piqua, O.

The Listening Post, Information and Filter Center Workers, Aircraft Warning Center, First Fighter Command, Mitchell Field, N.Y.

Library Bulletin of Abstracts, Universal Oil Products Co., 310 S. Michigan Ave., Chicago, Ill.

The Lockheed Aircraftsman, The Lockheed-Vega Log, The Lockheed-Vega Star, Lockheed Aircraft Corp., Burbank, Calif.

Luftschutz, Schweizerischer Luftschutzverband, Seidengasse 8, Zürich, Switzerland, Sw. Fr. 3.00.

The Lycoming Star, Lycoming Division, Aviation Corporation, Williamsport, Pa.

MAC Weekly Bulletin, McDonnell Aircraft Corp., Lambert Field, St. Louis, Mo.

Machine Tools, National Machine Tool Builders Association, Cleveland, O.

The Martin Star, The Glenn L. Martin Co., Baltimore, Md.

Mechanical Engineering, 29 W. 39th St., New York City, $6.00.

Mechanical Topics, The International Nickel Co., Inc., 67 Wall St., New York City.

Metals and Alloys, 330 W. 42nd St., New York City, $2.00.

The Military Surgeon, 7th and Independence Ave., Washington, D.C., $4.00.

Model Airplane News, 551 5th Ave., New York City, $2.00.

Model Aviation; Including Air Youth Horizons, Air Youth Division, National Aeronautic Association, 1025 Connecticut Ave., Washington, D.C., $1.00.

Modern Plastics, 122 E. 42nd St., New York City, $5.00.

Modern Transport, 105 Strand, London, W.C.2. 20*s.*

The Monthly Honker, Canadian Pacific Air Lines, 620 Dominion Sq. Bldg., Montreal, Canada.

Monthly Science News, 3 Hanover St., London, W.1.

Monthly Weather Review, U.S. Government Printing Office, Washington, D.C., $2.00.

Mundo Aeronautico, Rivadavia 945, Buenos Aires, Argentina, Pesos 4.00.

National Aeronautics, 1025 Connecticut Ave., Washington, D.C., $3.00.

The N.A.T.A. Dispatch, National Aviation Training Assn., 214 E. Armour Blvd., Kansas City, Mo.

New Horizons, Pan American Airways System, 135 E. 42nd St., New York City.

New York University, Contributions from the College of Engineering, University Heights, New York City.

News Digest, Hill & Knowlton, 350 5th Ave., New York City.

Nickel Cast Iron News, Nickel Steel Topics, Nickelsworth, International Nickel Co., 67 Wall St., New York City.

North American Skyline, North American Skywriter, North American Aviation, Inglewood, Calif.

North Ameri-Kansan, North American Aviation, Fairfax, Kansas City, Kan.

Northeast Airlines Gremlin, Northeast Airlines, Inc., Commonwealth Airport, Boston, Mass.

Northrop Life, The Northrop News, Northrop Aircraft, Hawthorne, Calif.

The Northwest Airlines Beam, Northwest Airlines, 1885 University Ave., St. Paul, Minn.

Observation Post, Ground Observer Corps, Aircraft Warning Service, First Fighter Command, Mitchel Field, New York.

The Official Foreign Air Mail Guide, 11 W. 42nd St., New York City, $1.50.

The Official Guide of the Airways, 608 S. Dearborn Ave., Chicago, Ill., $5.00.

The Ohmite News, Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill.

Pacific Aeronautical Library, Bulletin, 6715 Hollywood Blvd., Hollywood, Calif.

Parks Air News, Parks Air College, East St. Louis, Ill.

The Pegasus, Fairchild Engine & Airplane Corp., 30 Rockefeller Plaza, New York City.

The Pick-Up, All American Aviation, Inc., 209 W. 9th St., Wilmington, Del.

The Piper Pilot, Piper Aircraft Corporation, Lock Haven, Pa.

Picture News, Sinclair Refining Co., 101 W. 51st St., New York City.

The Polar Tech, The Argus-Leader Co., Sioux Falls, S.D.

Popular Mechanics Magazine, 200 E. Ontario St., Chicago, Ill., $2.50.

Popular Science Monthly, 353 4th Ave., New York City, $2.00.

Production Equipment, 328 S. Jefferson St., Chicago, Ill.

Production Information, Automotive Council for War Production, New Center Bldg., Detroit, Mich.

Ranger's Cloud Buster, Ranger Aircraft Engines Division, Fairchild Engine & Airplane Corp., Farmingdale, N.Y.

Republic Aviation News, Republic Aviation Corp., Farmingdale, N.Y.

The Resinous Reporter, The Resinous Products & Chemical Co., 222 W. Washington Sq., Philadelphia, Pa.

Revista de Aeronautica, Ministerio del Aire, Juan de Mena 8, Madrid, 100 Pesetas.

Revista de la Fuerza Aerea, Ministerio de Defensa Nacional, El Bosque, Santiago de Chile.

Revista do Ar, Aero Clube de Portugal, Avenida da Liberdade 226, Lisbon, 72$00.

The Rohm & Haas Reporter, Rohm & Haas Co., Washington Sq., Philadelphia, Pa.

Royal Aeronautical Society, Journal, 4, Hamilton Place, London, W.1, £3 3*s.*

The Royal Air Force Quarterly, Ideal House, Argyle St., Oxford Circus, London, W.1, 23*s.*

Ryan Flying Reporter, Ryan Aeronautical Company, San Diego, Calif.

The Saturday Evening Post, Independence Square, Philadelphia, Pa., $3.00.

Schweizer Aero-Revue, Schanzenstrasse 1, Bern, Switzerland, Sw. Fr. 10.00.

Scientific American, 24 W. 40th St., New York City, $4.00.

The Scrapper, Conservation Division, War Production Board, 420 De Soto Ave., St. Louis, Mo.

Service Engineering, Kent-Moore Organization, Inc., 485 W. Milwaukee, Detroit, Mich.

The Shaft, Summerill Tubing Co., Bridgeport, Pa.

Sheet Metal Industries, 49 Wellington St., Strand, London, W.C.2, 10*s.*

Shell Progress, Shell Oil Co., 59 W. 50th St., New York City.

Simmonds Aeronews, Simmonds Accessories, 21-10 49th Ave., Long Island City, N.Y.

Skyways, 30 Rockefeller Plaza, New York City, $3.00.

Soaring, Box 71, Elmira, N.Y., $2.00.

S.A.E. Accelerator, S.A.E. Journal, 29 W. 39th St., New York City, $10.00.

S.B.A.C. Press Summary, Society of British Aircraft Constructors, 32 Saville Row, London, W.1.

The Solar Blast, Solar Aircraft Co., Lindbergh Field, San Diego, Calif.

Southern Flight, 1901 McKinney Ave., Dallas, Tex., $2.00.

Spartan School News, Spartan School of Aeronautics, Municipal Airport, Tulsa, Okla.

Speed, Western Airlines, 510 W. 6th St., Los Angeles, Calif.

The Sperry News, The Sperryscope, Sperry Gyroscope Co., Manhattan Bridge Plaza, Brooklyn, N.Y.

The Sportsman Pilot, 515 Madison Ave., New York City, $3.00.

The Stabilizer, The Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, O.

Steam Car Developments and Steam Aviation, Nestling House, Sleights, Whitby, England, 12*s.*

Steel Horizons, Allegheny Ludlum Steel Corporation, Pittsburgh, Pa.

The Stinsonair, Stinson Division, Vultee Aircraft, Wayne, Mich.

Take-Off, North American Aviation, Dallas, Tex.

The Tale-Spinner, Army Air Forces Preflight School, San Antonio, Tex.

The Taylorcraft News, Taylorcraft Aviation Corp., Alliance, O.

Technical Data Digest, Matériel Center, Engineering Division, Army Air Forces, Wright Field, Dayton, O.

Technical Education News, McGraw-Hill Publishing Co., 330 W. 42nd St., New York City.

Technical News Bulletin of the National Bureau of Standards, U.S. Government Printing Office, Washington, D.C., $0.50.

Texaco Star, The Texas Co., 135 E. 42nd St., New York City.

To Keep 'Em Flying, Miami Beach Daily Tropics, Miami Beach, Fla.

Trade Winds, Wright Aeronautical Corp., Paterson, N.J.

Transactions of the A.S.M.E., 29 W. 39th St., New York City, $12.

Transatlantic Air News, American Export Airlines, 25 Broadway, New York City.

The T.W.A. Skyliner, Transcontinental & Western Air, Inc., 10 Richards Rd., Kansas City, Mo.

United Air Lines News, United Air Lines Corp., 5959 S. Cicero Ave., Chicago, Ill.

U.S. Air Services, Transportation Bldg., Washington, D.C., $3.00.

U.S. N.A.C.A. Technical Memorandums, N.A.C.A., Washington, D.C.

U.S. Steel News, U.S. Steel Corp., 436 7th Ave., Pittsburgh, Pa.

Victory, U.S. Government Printing Office, Washington, D.C., $0.75.

Vultair, Vultee Aircraft, Inc., Vultee Field, Calif.

The Vultee Volunteer, Nashville Division, Vultee Aircraft, Inc., Nashville, Tenn.

War Medicine, 535 N. Dearborn St., Chicago, Ill., $5.00.

War Production News, The B. F. Goodrich Co., Akron, O.

Washington News Letter, 1025 Connecticut Ave., Washington, D.C., $2.00.

The Wasp Nest, Pratt & Whitney Aircraft Div., United Aircraft Corp., Kansas City, Mo.

The Welding Journal, 33 W. 39th St., New York City, $5.00.

Welding News, National Electric Welding Machines Co., 1800 Trumbull St., Bay City, Mich.

West Coast Air Mail Society, Bulletin, 4142 26th St., San Francisco, Calif.

Western Flying, 304 S. Broadway, Los Angeles, Calif., $2.00.

Wheelco Comments, Wheelco Instruments Co., Harrison and Peoria Streets, Chicago, Ill.

Wings, McGraw-Hill Publishing Co., 330 W. 42nd St., New York City.

Wright at the Moment, Wright Aeronautical Corporation, Paterson, N.J

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AIRCRAFT FINISHES

House Organs and Catalogues

Aircraft Maintenance Equipment

Bulletin No. 102 combines information on models covered in bulletins previously issued and includes many new ones, most of which have been developed to meet wartime requirements. One of its primary purposes is to be helpful to men in the service, especially the young men who are learning aircraft maintenance work.

In addition to "service requirements," the booklet elaborates on engineering specifications. The purpose has been mainly to assist procurement officers and purchasing departments in requisitioning and purchasing equipment best suited to the types of aircraft under their jurisdiction.

Malabar variable-height jacks are featured as adjustable at varying levels to meet the requirements of different "jack-point-to-ground" distances and providing a wide latitude of service with the minimum of equipment inventory. They are collapsible for quick packing and limited shipping space.

Other Malabar equipment for airplane service is described. The Malabar leveling jack is for instrument checking and the Malabar weight finder facilitates the determination of airplane weights. *Malabar Machine Company*, Los Angeles, Calif.

Welding Accessories for Women

Are Welding Accessories for Women is the title of a new bulletin (GEA-3295) recently issued by the industrial department of the General Electric Company. The bulletin presents General Electric's line of safety clothing and equipment especially designed for girl welding operators.

Among the items illustrated and described are tailored leather welding jackets, sleeves, aprons, and gloves; flame-proof duck aprons and sleevelets; and a special flame-proofed hat designed to protect the hair from sparks and flying slag. This hat can be worn under any standard welding helmet. Also featured in the bulletin are protective goggles, ventilated hand shields, and plain and flip-front ventilated welding helmets.

The final section of the bulletin is devoted to various types of insulated metal-electrode holders and miscellaneous welding equipment such as slag chippers, scratch brushes, and fillet-weld gauges.

Plywood Aircraft

Structural Applications of Plywood in Aircraft. Keith Rider. It is explained that most so-called plastic airplanes really are constructed largely from plywood. With the commercial processes now in use plywood is bonded with phenol-resinous compounds instead of casein or albumin glues, but this has not changed the form or character of plywood, so it cannot be termed a plastic. A general discussion concerning the plywood airplane is presented, the writer first touching on the historic aspects of its development. To explain some of the characteristics that make plywood an excellent material for aircraft construction, some comparisons are drawn between this material and metal. Reference is made to the plywood-constructed airplanes made by Lockheed. Attention is drawn to the relatively small amount of equipment required to build aircraft of plywood. It is stated that with plywood-made aircraft parts the great bulk of the material used tends to prevent surface deformation that results in irregularities that cause drag. *American Aviation Sky-Gest*, January.

Salvage of Scrap

System for Scrap and Salvage. An article describing the system of salvaging scrap metal installed by the Thompson Aircraft Company. It is stated that all metal cuttings are not only salvaged for remelting but so processed that they are returned to productive use with a minimum of contamination and loss of time. The writer traces the various steps in the operation of this salvage system. *Steel Horizons*, Vol. 4, No. 5.

Instruction for New Employees

The Trend is to Training. A short article describes the program of training which has been developed by Fleetwings with the help of the U.S. Department of Education and the Drexel Institute. It has a dozen or more divisions and is said to be as useful in peacetime as in war. Among the courses are aerodynamics and airplane design, elements of aeronautical engineering, engineering drawings for aircraft, manufacturing processes, strength of materials, and lofting. The latter is described with details about its various sections, as well as the inspection course, field trips to the shops where actual work is observed, and other facts about the practical instruction that is given. *The Fleetwings' Arrow*, January.

Electric Control Catalogue

Replacing earlier publications on the subject, a new catalogue, N-00A, of 29 pages, is titled "Micromax Electric Control." It is intended for those required to solve automatic control problems, whether the controlled quantity is temperature, acidity, alkalinity, conductivity, or gas analysis. It describes control equipment capable of handling any process that can be controlled by positioning a valve or other regulating device, under either transient or sustained changes in demand.

Diagrams and text explain in detail how the equipment is adjusted to fit the needs of a particular process. Pictures show the equipment in actual use in a wide variety of applications.

A chapter explains the balance principle applied to measurement and control and shows how it can be adapted to various controllable processes. *Leeds & Northrup Company*, Philadelphia, Pa.

Metal Bellows Catalogue

A new 32-page catalogue on "Spring-Life" metal bellows has been issued by the Cook Electric Company, Chicago, Ill. The construction of "Spring-Life" bellows is described in the text and pictured with drawings and diagrams. Emphasis is placed on the strength of soldered joints. Following this is a discussion of the advantages of "Spring-Life" construction and a description of tests to destruction.

A discussion of the characteristics of "Spring-Life" bellows covers uniform pressure movement ratio, sensitive low-pressure response, ability to return to same "no-load" position, and resistance to corrosions. Data are given which enable the selection of bellows to fulfill particular requirements.

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Air-Line Schedule Research

The War Against "Too Late." An account of a series of studies made jointly by the Wright Aeronautical Corporation and the air lines during 1933-1938 to improve air-line schedules and to facilitate air transportation. The article tells how these studies were conducted, describes some of the findings, and gives some of the recommendations which, put into practice, have not only improved air-line travel but are now aiding the war effort. *Trade Winds*, February.

What the Engineers Do

A Bomber is Born. Second of a series of articles describing the construction of a Martin bomber from the creation of its design until its dispatch to the fighting fronts. In this article the engineering department's part of the job is detailed. Tracing the routine of the department's work and noting the factors that must be considered, the article points out the fact that the engineers are not only concerned with the original design of the airplane but are constantly working on changes to be incorporated. *The Martin Star*, March.

Douglas Plant in Africa

African Shangri La. Robert C. Neville. With locations and relative information deleted, some data are given on a secret aircraft factory and repair station established by the Douglas Aircraft Company in Africa. The transportation of personnel to this factory, as well as problems connected with their health, comfort, and living conditions, is noted. *Douglas Airview*, January.

Trailers for Training

Flying Fortress Road Show. This article tells how hydraulic, electric, fuel, and other systems and equipment of the Flying Fortress were installed by the Boeing Aircraft Company in trailers to form efficient mobile training units because it was not possible to send Army Air Forces mechanics to Seattle to learn Flying Fortress maintenance. *Boeing News*, February.

Wanted: New Bombers

The Air War & Armament. For effective offensive bombing, this article states, the following equipment must be developed: fast, unarmed, long-range bombers, capable of running away at a speed faster than any fighter that can be put into the air to intercept; heavy, well-armed bombers, possessing long-range cannons, capable of shooting down fighters before they can get within range to use their own armament; high-altitude, pressure-cabin bombers for mass night or day, clear weather bombing on selected areas, as distinct from bombing individual factories. The article outlines specifications for these types of airplanes and describes the purposes they would fulfill. In addition to the use of such equipment for strategic attacks on targets in German territory, it discusses how these bombers could be utilized in new tactics against shipping. The changes in the standardization of equipment and personnel which could take place if such airplanes were available are speculated upon. *General Aircraft News*, January.

War Production

Our Part in the War Effort. The part the United Aircraft Corporation is taking in the war production program is portrayed in a 20-page pamphlet. Highlights in the production of Pratt & Whitney engines, Vought and Sikorsky airplanes, and Hamilton Standard propellers are presented. Photographs are shown of engines, airplanes, and propellers in process of manufacture The aims and principles of the company in carrying forward the war effort are outlined.

Fire Extinguisher Recharging

How to Recharge a Carbon Dioxide Extinguisher. An illustrated article tells how industrial plants can charge their own carbon-dioxide fire extinguishers with the aid of a few simple accessories. Both the cooling and pump methods of transferring liquid carbon dioxide from commercial cylinders to extinguisher bottles are described. Advantages of the pump transfer method where built-in systems are used or when a large quantity of portable extinguishers must be filled are outlined. *High Pressure*, February.

Device for Gauging Strain

What's New in Testing? Gail H. Swan. The function, operation, and construction of an electrical gauge for measuring strain under static tests are described. Recently installed at the Fleetwings plant, the application of this apparatus is based on the principle that certain wires of fixed initial length vary in electrical resistance in proportion to their change in length. It is said to be capable of recording within 1 min. the strain at 48 different points on a structure. One of the advantages claimed for the gauge is that it will enable the accurate determination of true load distribution in complicated structures. *The Fleetwings' Arrow*, February.

Made by Curtiss-Wright

Curtiss-Wright Aircraft . . . 1943. Supplemented by descriptive data, photographs are shown of eight Curtiss-Wright models now serving the Army and Navy. These are the P-40F Warhawk, the AT-9 Jeep, the C-76 Caravan. and the A-25 used by the Army; the SO3C-1 Seagull, the SB2C-1 Helldiver, and the SNC-1 Falcon used by the Navy; and the Commando or R5C-1 used by both the Army and the Navy. *Curtiss Flyleaf*, November-December.

Duramold

Regarding "Plastic" Planes—Part Two. Part 2 of an article on Duramold and its use in airplane construction. In this installment it is shown how, in order to obtain the maximum use of Duramold, other groups are developing arts and data in addition to those directly connected with the process of making the material. One of these groups, called "Durastructures," is concerned with the problems of making light and economical joints between pieces of Duramold or other low-density materials. The second, called "Durassembly," deals with the problems of economically assembling the pieces of Duramold. "Durafinish," the third group, is devoted to methods of finishing the assemblies made of Duramold as differentiated from the finishes that may be incorporated as part of the molding of the material. *The Pegasus*, March.

Nitriding Catalogue

Leeds & Northrup Company has issued a 19-page revised edition of its catalogue, designated as T-624, describing the Homo nitriding method. Based on a system of forced circulation, this method is intended to give heat-treaters precise control of the three important variables—nitriding temperature, flow and distribution of ammonia gas, and duration of treatment. The manufacturers state that control of these factors enables men to nitride parts to exact specifications in substantially less than the usual time and to control each batch of work so systematically that the required qualities can be duplicated easily and surely. The booklet contains charts of surface hardness and case depth, tabulated specifications of nitriding furnaces, and descriptive matter on the furnaces, their installation and use.

Plant Engineering

An Airplane is Born. Part VII of this continued article is concerned with the contributions of plant engineering to the production of an airplane. Three main functions of this department are briefly described: construction, service, and maintenance. Examples are given in evidence of improved plant engineering methods employed at the Ryan factory. *Ryan Flying Reporter*, February 12.

Metallurgic Research

Metallurgy vs. Metal-Urgency. A. H. Petersen. The importance of metallur-

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Full 360° rotation. Built to AN Specifications. Nothing to tighten or adjust. Adaptable to individual manufacturers' requirements . . . for oil and fuel lines, brake lines, hydraulic control lines . . . wherever movement is essential.

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Made from aluminum alloys, steel or other materials suitable to the purpose for which they are to be used.

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gic studies to aircraft construction is noted and some idea is given of how the work is carried out at Vega. A few achievements in this field, as well as the men responsible for them, are mentioned. *The Lockheed-Vega Aircraftsman*, January.

Precision Lathe Catalogue

Catalogue No. 10 describing South Bend 10-in. precision lathes has been issued by the South Bend Lathe Works, South Bend, Ind. This 8-page file-size catalogue illustrates and describes the company's 10-in. toolroom lathes and 10-in. quick-change gear lathes in both floor leg and metal bench models. Attachments, accessories, and tools for use with these lathes are also listed. The construction features of the lathes are illustrated and specifications are tabulated for ready reference.

Handbook on Roller Chains

A 32-page handbook on roller chains and sprockets for aircraft describes the construction and advantages of these devices. It contains specifications and uses for which roller chains are suitable and tables of sprocket wheel diameters for chains of various sizes. Dimensions of chains, standard links, and special links are tabulated, and information on the principles governing the selection of roller chains for aircraft is given. A chart provides a method for finding chain length and center distance. Other tables cover the hardness and tensile strength relationship of carbon and low-alloy steels, sprocket-tooth section profile dimensions, and maximum hub diameters. Remarks are made on installation, lubrication, and maintenance of roller chains. *Diamond Chain & Manufacturing Company*, Indianapolis, Ind.

Soaring Aid

Artificial Thermals. Leonard Taylor. The writer proposes that a system be devised for locating areas of artificial heat to assist the soaring pilot when natural thermals are not available. No specific plan is presented, but the opinion is offered that it is a duty of the State to provide such facilities. *General Aircraft News*, January.

Dumore Aircraft Motors

A recent loose-leaf catalogue contains a selection of bulletins giving specifications, dimensions, and descriptions of several models of electric motors designed to operate various aircraft accessories. It also gives information on the field of application of these motors, their construction, special features, and performance. Illustrations and condensed descriptions are included on custom-built motors for special applica-

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Photographs courtesy PAN AMERICAN AIRWAYS SYSTEM.

{Large Photo} Pan American's Strato-Clippers {4-engined Boeing-307's} are commercial versions of the Flying Fortresses.

{Below} Checking in Strato-Clipper express and mail... up from South America in less than a day!

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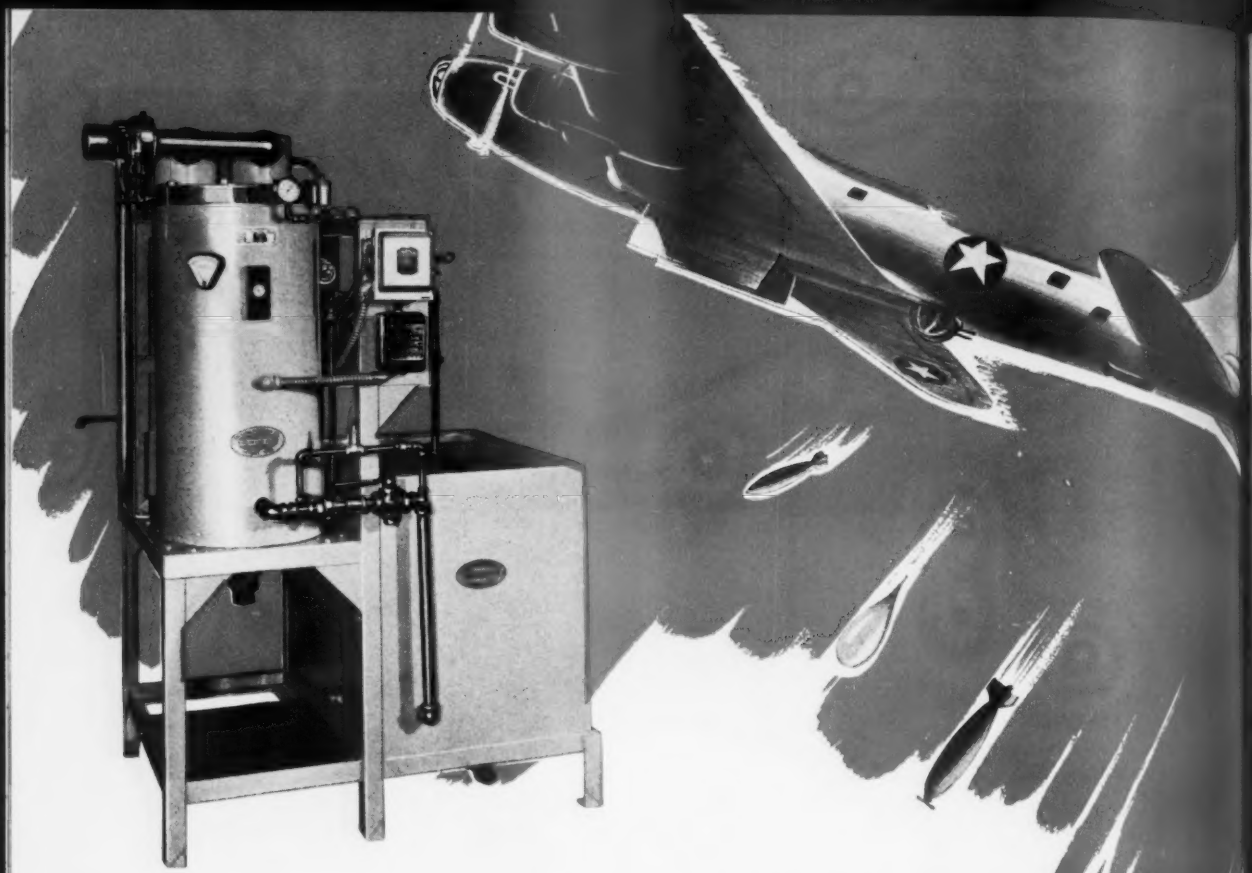

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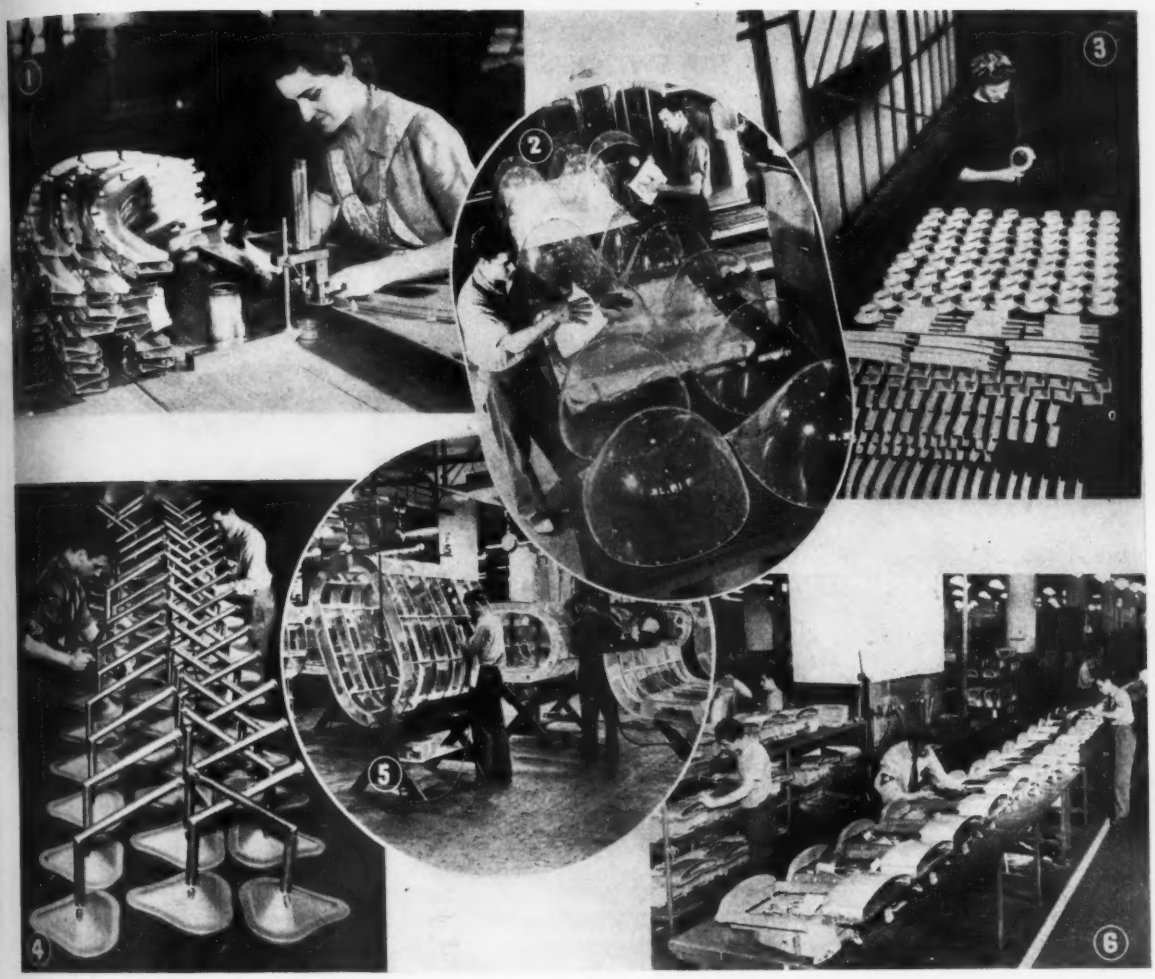

The six photographs shown here illustrate some of the thousands of small parts manufactured by the Detroit Aircraft Unit, the fabricating and subassembly plant for the Fisher Body Division of General Motors. (1) The painting of left lines on a fuselage frame section to determine the location for rivets on final assembly. (2) Polishing transparent plastic tail observation cones. (3) Hundreds of small parts, including fuselage frame angles of which only one is used in a plane; flat torque tube collars, two of which are used in each ship; and nacelle fire extinguisher door releases, two of which are used in each plane. (4) Bombardier stools on the inspectors' tables. (5) Assembly of auxiliary fuel tanks. (6) Carburetor air scoops that contain at least 100 parts, not including the rivets.

tions. *The Dumore Company*, Racine, Wis.

Air Transport Survey

The Cargo Plane's Priority Passenger. A detailed survey undertaken by technicians of the Standard Oil Company (N.J.) is reported. The object of the study was to determine the potential market possibilities for aircraft fuel after the war and to explore the possibilities of air transport by comparison with surface vessels for overseas commerce.

It is found that the weight of fuel is one of the most important factors to be considered in long-distance air transport and that the availability and location of fuel supplies will be a determining factor in the feasibility of carrying heavy cargo by air to distant points.

It is shown that the heaviest type of cargo planes, probably larger than any constructed to date, is likely to prove economically feasible and that smaller planes of the so-called light or medium class would not be satisfactory because the weight of fuel required would exceed the potential pay load. The efficiency of an airplane in cargo transport would depend upon the number and location of fueling stops that could be arranged, so that minimum weight of fuel would permit the maximum amount of net cargo.

Figures are presented in the form of charts and graphs to show suggested war routes, the relative cost of planes and oil facilities to maintain them, the tons of fuel consumed per ton of cargo carried, and a comparison of tankers for refueling with the cargo ships replaced. *The Lamp*, March 8.

Plywood Airplanes

Combat Planes of Plywood. A brief article tells of the use of Tego-bonded plywood in the construction of the Curtiss Caravan and the de Havilland Mosquito. In addition to the advantages attributed to the material in these two types of airplanes, the properties of plywood bonded with Tego and Amberlite PR-14 are described and uses for these materials in other types of aircraft are mentioned. *The Resinous Reporter*, February.

Assembly-Line Production

Automotive Technique of Progressive Assembly Adapted to Manufacture of Aircraft Wings. An article telling how the power-driven assembly-line production methods similar to those used in the automobile industry are now being used to speed the production of aircraft. The step-by-step process whereby raw materials are transformed into parts, parts into subassemblies, and subassemblies into the finished product with the flow-production method is oulined. *Automotive War Production*, February.

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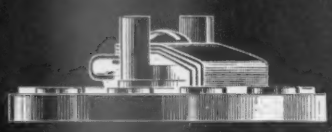

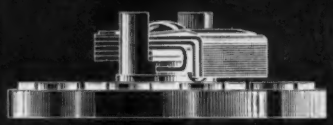

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Efficiency for All Parts

Aircraft are a "Rough Job." The design and construction of detail parts in the average airplane are criticized as falling short of engineering perfection. Demonstrating the results of such inefficiency, the writer blames the condition mainly upon the failure of the design office to detail unstressed components and the lack of cooperation between shops and drawing department. The suggested "cure" is a general adoption of high engineering standards extending to all components. *General Aircraft News*, January.

War Production

Teamwork for Victory. A pamphlet has been issued telling how the automotive industry is meeting commitments made to the nation when at the close of 1941 the Automotive Council for War Production was formed. Achievements attained in war production are described. Sections of the pamphlet are devoted to aircraft, tanks and combat vehicles, guns and ammunition, military vehicles, and marine equipment. *Automotive Council for War Production*, Detroit, Mich.

Handbook on Blind Rivets

A 16-page handbook designed to aid those who are concerned with riveting operations on aircraft has been issued by the Cherry Rivet Company, Los Angeles, Calif. Information on the Cherry riveting process is given, together with instructions on the operation and care of Cherry rivet tools. Charts, diagrams, dimensional sketches, and photographs present a clear picture of how Cherry Rivets are used for new air-frame construction, field repair, and air-frame salvage.

Other subjects covered in detail are: specifying rivets, grip length, the handling and storing of rivets, the preparation and drilling of material, and the operation and care of riveting guns. Descriptions of gun accessories and interchangeable pulling heads are included, with charts on material thickness and standard rivet sizes.

Lathe Installation

The installation and leveling of lathes is described in Bulletin H-3, published by the South Bend Lathe Works, South Bend, Ind. The bulletin discusses the proper method of installing lathes for efficient operation. Information on unpacking, supporting, securing, and illuminating lathes is given and layout and transverse leveling are also discussed. The bulletin is written especially for lathe operators, millwrights, and plant superintendents.

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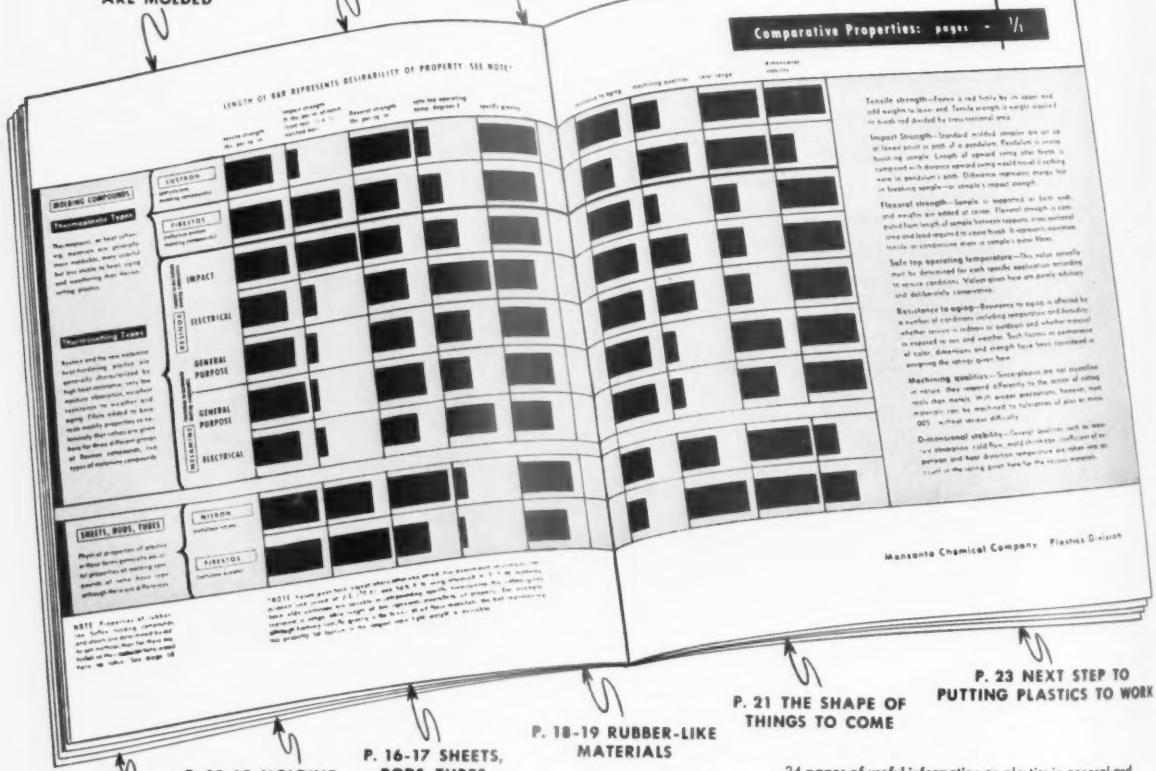

P. 9 ELECTRICAL PROPERTIES

P. 10-15 MOLDING COMPOUNDS

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The Ducks Have Left the Loft. Explanation of the Fleetwings Spline-Lock. This device for holding lofting-board splines in position has replaced the lead ducks formerly used for this purpose. Applicable for both horizontal and vertical lofting on metal surfaces, the Spline-Lock consists essentially of a vacuum cup approximately $2^1/_4$ in. in diameter which incorporates a hook or finger for holding the spline. In addition to permitting vertical work, it is stated, the new device has resulted in a number of other advantages. These include easier handling, more secure holding ability, and lower cost. *The Fleetwings' Arrow*, February.

Planned Engineering

Production-Minded Engineering Planning. R. W. Ayer and E. M. Westberg. An account of how Fleetwings' engineering work is coordinated with that of its shop by a comprehensive engineering planning system. The article outlines the methods whereby the Engineering Planning Division fulfills the following four purposes: (1) the budgeting of all projects on a man-hour basis; (2) the setting up of release schedules to conform with shop schedules; (3) the establishment of a systematic means for daily and weekly progress reporting; and (4) the collection and compilation for later use of data on engineering performance. A typical job is described to illustrate the various phases of Engineering Planning. *The Fleetwings Arrow*, February.

Training Aircraft Technicians

"A Modern Army Fights on its Tool Kit." The article briefly describes how Army and Navy technicians are being turned out by General Motors military schools. Particular reference is made to the Pratt & Whitney aircraft school, which is staffed with instructors from the Chevrolet Division of General Motors. *Service Engineering*, Winter, 1943, page 15.

Aircraft Fire Control

Pan American Airways Keeps Two Jumps Ahead of Fire. This article describes the equipment and methods used by Pan American Airways for the control and prevention of aircraft fires. The operation of the Kidde built-in fire extinguishing system used for putting out engine fires is outlined. The planes are also equipped with portable extinguishers. *High Pressure*, February.

New N.A.S. Standards Sheets

The National Aircraft Standards Committee has issued, as of December, 1942, 40 additional national aircraft standards sheets. They comprise NAS-34 to NAS-38 inclusive; NAS-205 to NAS-235, inclusive; and revision of NAS-150. These cover pulleys, bearings, recessed screws, and bolts.

Procurement of Materials

Buying Materials of War. A summary of the special but interrelated functions of the various sections comprising Boeing Aircraft's Materiel Department. The article outlines the duties of: the material control procurement (divided into three subsections—Airframe Requirements, General Requirements, and Outside Production), Operations, Priorities, Traffic, and Claims and Adjustment sections. *Boeing Contact*, January.

Cyclone Crankshafts

"Crankshaft by Ohio." An article on how crankshafts for Wright Cyclone engines are manufactured by the Ohio Crankshaft Company. The coordination and cooperation between the two companies and the facilities, manufacturing methods, personnel, and training system of the crankshaft maker are described. Data are included on the "Tocco" process of induction heating and surface-hardening, developed by Ohio Crankshaft, to obtain a durable finish for greater resistance to wear at high speed and heavy power. *Trade Winds*, February.

Engineering Contributions

Westinghouse Wartime Engineering is the title of a 32-page illustrated brochure which relates the diversified activities of the company in the war production program. In addition to devices such as fire control instruments and other ordnance items, details are given on numerous accessories and instruments for use in aircraft, among which are aircraft generators and motors, lamps and searchlights, compressed air apparatus, aircraft radio instruments, and many others. Descriptions are given of the apparatus employed by the company in the manufacture of these devices and the services they perform. Methods that have been developed for speeding manufacturing processes are detailed. The booklet emphasizes the wide variety of Westinghouse contributions to war production, ranging from delicate instruments to turbogenerators and motors for driving the capital ships of the Navy. *Westinghouse Electric & Manufacturing Company.*

S.A.W.E. Yearbook

The 1943 yearbook of the Society of Aeronautical Weight Engineers has been issued. It contains the society by-laws, the roster for the preceding year, summaries of meetings and business transacted, accomplishments, the proposed program for the following year, and items of general interest to members and others interested in the activities of the Society.

(*Continued from page 39*)

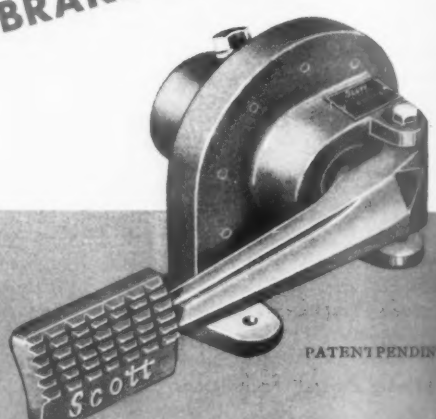
panel load system is then computed, and the resulting expression is differentiated with respect to the strain parameters. The seven resulting equations define the equilibrium configuration of the panel. Expressions are obtained for the critical condition, principal midplane stresses, maximum web bending stresses, stiffener and cap compressive stresses, web wave length, wave angle, and wave depth. In particular, a formula is given for the bending loads on the stiffeners produced by the wrinkling of the web. The equations are shown to reduce to those of Wagner for an infinitely thin web. A comparison is presented which shows good agreement between theoretic and experimental values of principal web stresses, stiffener compressive stresses, wave depth, and wave length.

Vibration Recording Equipment

Experimental Investigations in Aircraft Dynamics by William B. Bergen, of The Glenn L. Martin Company, presented an exhaustive and well-written report of the vibration studies that have been made at this plant. Together with the design of the flying boat Mars, there has come the development of a great amount of electrical vibration recording equipment especially designed for the study of aircraft flutter. One particular feature of the equipment is a mechanical vibrator that is remotely controlled to produce artificial excitation in flight. Another phase of the paper dealt with the dynamic loads encountered by aircraft structures under service conditions, as, for example, in nose wheels.

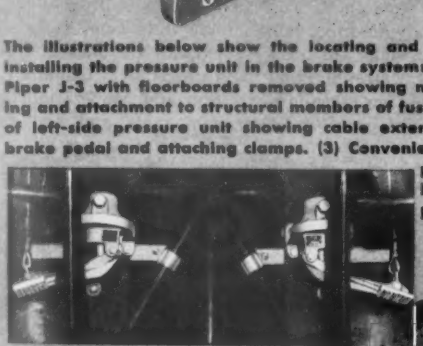
IT'S SMOOTHER, SURER STOPS WITH THE NEW SCOTT "B-711" BRAKE PRESSURE UNIT

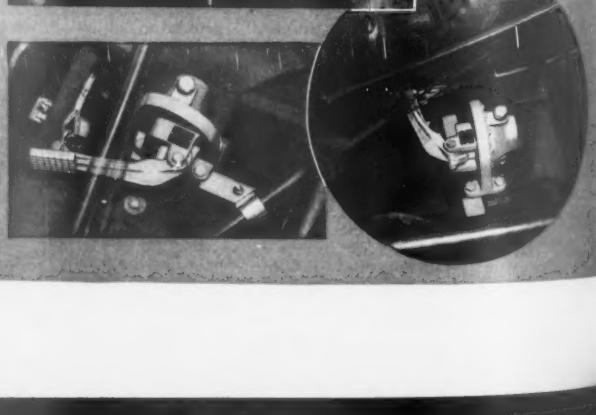
There's a real feeling of confidence when your heels engage the pedals of the newly-developed Scott Brake Pressure Units. You ***know*** you come to a smooth, safe stop when and where you want to. That's because these new hydraulic pressure cylinders are positive in action—absolutely fluid-tight—assuring top efficiency from the brake system. Designed for use on light aircraft using the expander tube brakes, these units may be adapted to other braking systems. Readily installed, and located with pedals in conventional relationship to the rudder pedal. Scott B-711 Brake Pressure Units are simple in design, durably constructed, light in weight (only 21 ounces). Each unit is exactingly tested to assure dependable, long-term performance. Economically priced. Write for illustrated folder.



PATENT PENDING

The illustrations below show the locating and simple method of installing the pressure unit in the brake system: (1) Installation on Piper J-3 with floorboards removed showing method of reinforcing and attachment to structural members of fuselage. (2) Close up of left-side pressure unit showing cable extension to front seat brake pedal and attaching clamps. (3) Convenient arrangement of pressure unit pedal, located for easy, positive operation.





Scott AVIATION CORPORATION
LANCASTER, N. Y., U. S. A.
DESIGNERS AND MANUFACTURERS OF SPECIAL EQUIPMENT FOR THE AIRCRAFT INDUSTRY

SUPPLIERS TO THE U. S. ARMY AND NAVY AIR FORCES AND LEADING AIRCRAFT MANUFACTURERS

From the Industry

Colloidal Compounds

A 4-page illustrated bulletin, No. 422-B, on the use of "dag" colloidal graphite as a parting compound has been published by the Acheson Colloids Corporation, Port Huron, Mich. This bulletin discusses "dag" colloidal graphite for screw threads, lamp bulbs, its application to aviation and deep-sea diving equipment—also its use in the glass industry, in the foundry, and in the rubber industry.

Automatic Bucker

Bucking and riveting simultaneously is the purpose of a new automatic bucker recently announced by the Aero Tool Co., Burbank, Calif. The makers state that one woman can do work that would otherwise require two operators in riveting airplane and other sheet metal parts.

The Aero Tool automatic bucker with 22-in. throat weighs 14 lbs. and with 36-in. throat weighs 16 lbs., including gun. It is used with any standard rivet gun and can be furnished with specially designed heads for any type of aircraft construction. Parallel yokes provide for side panels, wings, and leading edges, with special yokes for engine cowling and other parts requiring extra clearance. On horizontal structures rivets can be preloaded. On vertical structures rivets can be inserted in the usual manner or can be preloaded and taped. High-grade seamless tubing and alloy-steel castings are used. Opening and travel of the bucking bar are stated to be limited only by the accessibility of the part to be riveted.

Aeronautical Chamber Reorganized

The reorganization of the Aeronautical Chamber of Commerce of America has been announced.

James P. Murray, vice-president of Boeing Aircraft Company, was elected president of the Chamber and I. H. Taylor of Washington, D.C., was made general manager. Three vice-presidents were elected: J. Carlton Ward, Jr., president of Fairchild Engine & Airplane Corporation; C. S. (Casey) Jones, president of Casey Jones School of Aeronautics; and J. Story Smith, vice-president of Jacobs Aircraft Engine Company. Frank N. Fleming, assistant secretary and Washington representative of Douglas Aircraft Company, Inc., was elected secretary, and John E. P. Morgan, Washington representative of a group of light-plane companies, was elected treasurer.

The Executive Committee includes J. A. B. Smith, vice-president of Curtiss-Wright Corporation, chairman; Frederick R. Neely, Bell Aircraft Corporation; John Montgomery, Consolidated Aircraft Corporation; Carl Friedlander, president of Aeronca; Joseph T. Hartson, executive vice-president of The Glenn L. Martin Company; L. T. Cohu, Northrup Aircraft Corporation; and Charles Marcus, vice-president of Bendix Aviation Corporation.

Book on Welding Piping

The Welding of Piping is a treatise of 16 illustrated pages, consisting of a series of articles prepared by the Air Reduction Company's Applied Engineering Department.

It covers various types of ferrous and nonferrous piping, their dimensions, fabrication, and estimates of welding and labor costs.

Oxyacetylene Flame-Adjustment Color Chart

The Air Reduction Company's new chart for oxyacetylene flame adjustment has been prepared particularly for the guidance of new welders. It shows natural color photographs of five fundamental flame adjustments: (1) acetylene burning in air, (2) a strongly carburizing flame, (3) slight excess of acetylene flame, (4) neutral flame, and (5) an oxidizing flame.

Being graphic, it is intended to convey the proper appearance of the various welding flames faster and more accurately than any amount of descriptive instruction. This chart is an important guide for every welder, because even the best manipulative welding skill is wasted unless flame adjustments are correct.

Planning Postwar Aluminum Uses

The Aluminum Company of America has prepared a report in considerable detail on its activities in planning for postwar applications for aluminum. The study presents statistics on estimated production of aluminum in 1943 and discusses the expansion that has been made and is under construction in facilities for producing aluminum as a raw material and in the semifinished form.

It is indicated that three factors will, in general, influence the use of aluminum in the postwar market, these being price, quantity available, and the increased number of workers experienced in fabricating and handling aluminum. These three factors are discussed at considerable length. The possibility of finding new applications for aluminum are explored, it being shown that numerous products can be made of this material after present wartime demands are fulfilled. Aluminum Company of America, Pittsburgh, Pa.

Hollow Steel Propeller Blades

Hollow steel propeller blades are processed by the American Propeller Corporation, a subsidiary of The Aviation Corporation, from single pieces of tubing. These blades are reported to be lighter than aluminum blades in the larger sizes and offer great resistence to corrosion and abrasion. They are made by a special process that lends itself readily to quantity production methods.

American Propeller Corporation recently announced the purchase of additional equipment that will increase its plant capacity by 50 per cent.

Industrial Stitching Wire

A new type stitching wire has been developed by the American Steel & Wire Company, subsidiary of the United States Steel Corporation, for the fastening of rubber, plastics, fiber board, laminated wood, and other construction materials to stainless steel or aluminum. Its use is claimed to permit stitches to be made at the rate of several hundred per minute, resulting in substantial savings of time by several leading aircraft manufacturers in the fabrication of nonstressed parts and in the application of rubber sealing to hatch doors, landing gear doors, and similar parts. Heating ducts and shrouds can be lined with asbestos and a tight bond secured between the asbestos and material by use of these stitches. Cold-air ducts, first-aid kits, and ammunition boxes also can be

"sewed" into their proper places by use of the material.

The new stitching wire is of a special analysis, stated to have minimum tensile strength of 290,000 lbs. per sq.in. It has a zinc coating intended to withstand a salt spray for a period of several hundred hours, in accordance with Army Air Forces specifications. The makers state that the wire will penetrate stainless steel of 0.030 in. thickness, Duralumin of 0.040 in. thickness, or aluminum of 0.060 in. thickness. Other softer materials such as rubber, wood, asbestos, cork, etc., can be penetrated to a thickness of 3/4 in.

Steel Analysis Chart

A revised standard steel analysis chart has been published by American Steel & Wire Company, subsidiary of U.S. Steel, to aid in wartime steel users. The chart, which includes modifications and changes in the analyses of A.I.S.I., S.A.E. and the new NE steels up to February 1, 1943, folds up to a small, compact size for easy reference.

A new feature is the breakdown that shows whether or not various types of products are available in specific analyses, together with the listing of the proportionate amounts of different component elements used in producing the various grades of steel. The chart covers carbon and free-cutting steels, manganese, nickel, nickel-chromium, and molybdenum steels, in addition to chromium, chromium-vanadium, silicon-manganese, and National Emergency steels.

Extruded Aluminum Bronze

Bulletin No. 110 describes extruded aluminum bronze produced to meet Aeronautical Material Specifications Nos. 4630A, 4632, and 4640. For these specifications the maker offers Ampcoloy A-3 to meet AMS 4630A and 4632, covering low-iron type aluminum-bronze alloys. Ampcoloy 45 is offered to meet AMS 4640, a high-iron nickel composition aluminum bronze. Ampco Metal, Inc., Milwaukee, Wis.

Paint Spray Booths

Various models of paint spray booths and dust-collection systems are described and illustrated in a folder that shows the features of this type of equipment. In operation, the side and rear water-impingement walls of these spray booths are continuously covered with a sheet of water under control. This method of air cleaning requires no spray nozzles or moving parts, and high averages are reported for the reclamation of pigments. Aqua-Restor Division, Mayer Manufacturing Corporation, Brooklyn, N.Y.

New Bakelite Phenolic Plastics

Bakelite Corporation, a unit of Union Carbide and Carbon Corporation, New York, has announced the development of a phenolic molding material, BM-13017, designed especially for the production of aircraft and automotive ignition parts. The material is natural colored and is claimed to be suitable for extrusion molding around inserts. Physical and electrical molded properties have been determined by A.S.T.M. (or standard) samples under A.S.T.M. (or standard) tests. Pieces were molded under conditions planned to impart their best finished properties.

BM-16034 is the number of another new Bakelite phenolic molding plastic recently announced by Bakelite Corporation. This material was developed for long flow extrusion work and for transfer molding.

Army and Navy Primary Trainers

The Boeing Kaydet Primary Trainer (Army), also designated Boeing N2S-3 Primary Trainer (Navy), is a two-place open-cockpit biplane of welded steel tube fuselage frame construction, with built-up, fabric-covered wooden wings. Its landing gear is of full cantilever construction and is reported to be the first shock absorber of its kind used on a military training plane. Nothing moves on the landing gear but the wheels and the shock absorber. The landing gear can be removed by detaching four bolts.

The plane is powered by a 220-hp. Continental engine. Simplicity of the engine mounting is credited for permitting engine change in two hours and facilitating maintenance in the field.

The Kaydet has a top speed of 125 m.p.h., a cruising speed of 100 m.p.h., and a cruising range of 400 miles. Boeing Airplane Company.

Free-Machining Low-Expansion Alloy

The Carpenter Steel Company, Reading, Pa., has completed the development of a free-machining grade of Invar, now in commercial production, intended to overcome the machining difficulties that have limited the use of Invar 36 per cent nickel alloy.

For some time, Invar, in various forms, has been used in applications where expansion under heat must be minimized. By providing a rate of thermal expansion approximately one-tenth that of carbon steel, at temperatures up to 400°F., this alloy is being used in controls, thermostats, etc.

Whereas regular Invar bar stock is extremely difficult to machine, the new type is claimed to machine easily, at a saving of as much as 72 per cent in machining time. The makers state that the addition of selenium to the alloy gives it free-cutting properties yet does not alter the metal's low thermal expansion characteristics.

Fluorescent Inspection Light

Commercial Reflector & Manufacturing Company, Los Angeles, Calif. has recently introduced a new fluorescent inspection light.

Combining the fluorescent lamp with the unbreakable features of plastic Lucite, this new portable light is intended for inspection use in inaccessible places in aircraft, ships, military tanks, and many other types of industrial applications.

The light is easily taken apart for lamp replacement by removing two screws. A combination metal light baffle and support shields light from the inspector's eyes. Standard cord plug and ballast box with 20 ft. of cord complete the equipment.

Balanced Armature Relay

The Cook Balanced Armature Relay is a double-action interlocking control unit with balanced armature control. It can be made to fit into designs where its light weight and small size are essential. It is built to withstand the constant vibration and sudden shocks of mobile applications.

This relay is available in various contact arrangements or with micro switches in place of spring pile-ups. Capacities range up to 5 amp., 110 volts a.c. rating; coil capacity is 10,000 ohms each; contact forms or assemblies are available up to twelve springs on each side. Dimensions are 2 3/4 in. long, 1 15/16 in. high and 7/8 in. deep. Cook Electric Company, Chicago, Ill.

Solvent for Cleaning Metals

A new solvent is offered as a substitute for carbon tetrachloride for cleaning metal parts. It is described as a volatile, water-white methylated hydrocarbon solvent that evaporates clean and is nonflammable and nonexplosive.

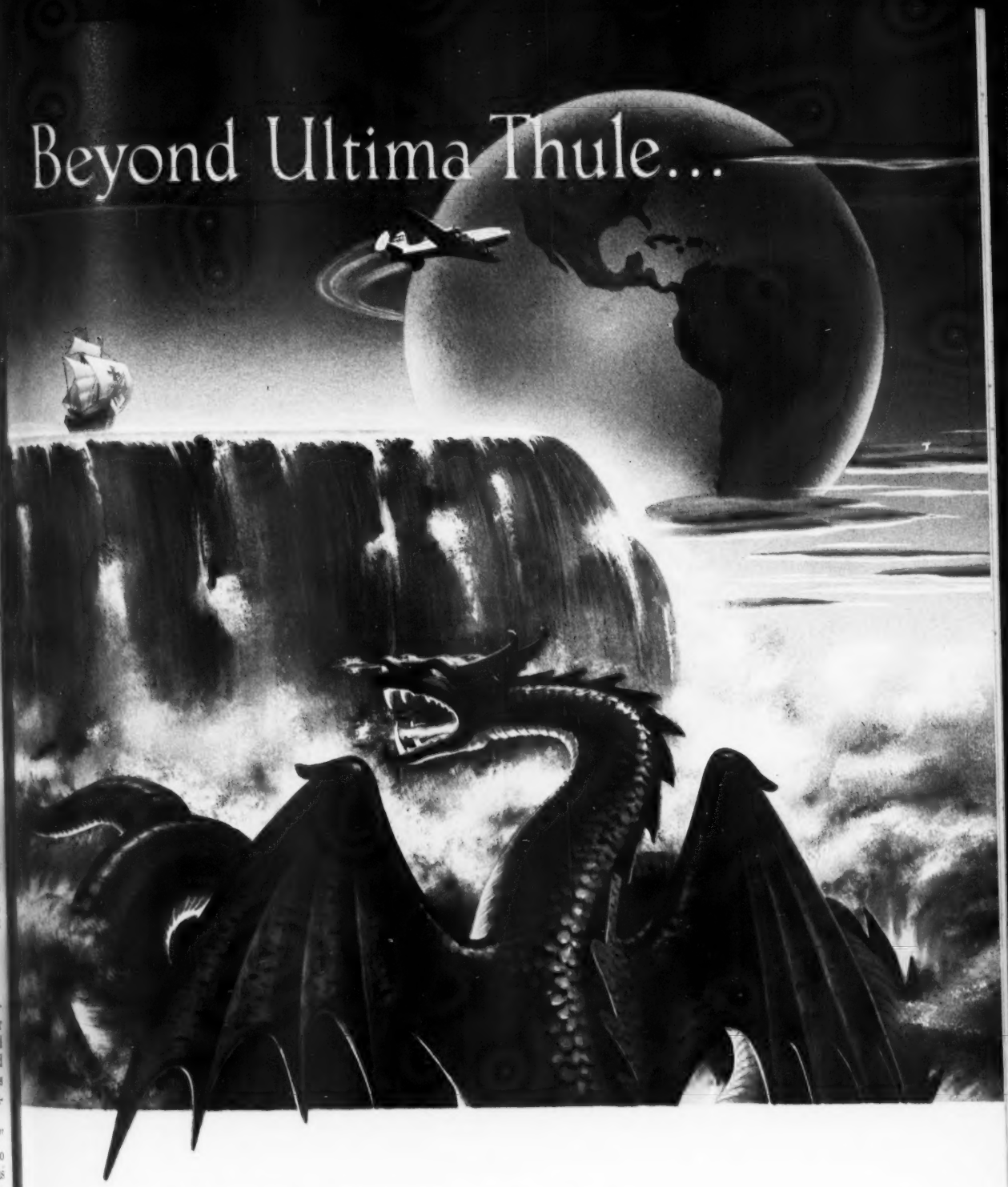
The new product is a "nonpolar" solvent and is claimed to induce no corrosive or rusting tendency of ferrous metals and to be less toxic than carbon tetrachloride, which it is intended to replace. The Curran Corporation, Malden, Mass.

Guide to Wright-Powered Warplanes

A revised edition of the *Guide to Wright-Powered Army, Navy and British Warplanes* contains a list of the designations, missions, and horsepower ratings of the Wright engines used in current war aircraft.

In addition to the planes listed, the new Lockheed (C-69) Constellation is powered with four Wright Cyclone 18

Beyond Ultima Thule...

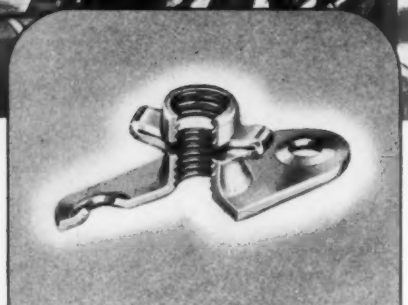


WHEN the ancients believed the earth was flat, *Ultima Thule* was the unexplored—the unknown at the remotest edge, where the sea cascaded into space. Until the coming of the airplane an Ultima Thule of undeveloped territory and commerce still existed behind economic barriers of time and distance. Today's aircraft have pierced those frontiers . . . tomorrow's transports will reach beyond, making the entire world easily accessible to all.

LIGHT · COMPACT · POWERFUL

Wright ENGINES

WRIGHT POWERS THE TONNAGE OF THE AIR



Saver of Precious Metal

Because Boots Self-Locking Nuts are lighter, they save hundreds of tons of strategic metal. The Anchor Nut (shown in cross-section above) is the type of Boots Nut most commonly used on military planes. It operates on the familiar Boots self-locking principle. The threads of the top, locking section are slightly out of phase with those of the lower, load-carrying section. When the bolt engages the locking section, a constant pressure is established which prevents any loosening due to vibration.

Here's More Fire-Power to You, Sergeant!

The lighter the plane, the greater can be its fire-power. Every pound saved in airplane construction therefore becomes a vital factor in winning the war.

Planes of all types, from the greatest four-motored bomber down to the small pursuit or trainer, are made with Boots all metal, self-locking nuts. On a heavy bomber, this means a saving of more than sixty pounds—enough for 200 rounds of .50 calibre machine gun bullets.

Boots all-metal nuts are not only lighter, but literally "outlast the plane."

Specially developed for motor application, the new Boots "Rol-Top" Self-Locking Nut is winning a wide acceptance among engine manufacturers.

BOOTS

Self-Locking Nuts For Application In All Industries

BOOTS AIRCRAFT NUT CORPORATION ★ GENERAL OFFICES, NEW CANAAN, CONNECTICUT

engines of the 2,000-hp. series. Curtiss-Wright Corporation.

Operating Analysis Chart on Hydraulic Packings

A new operating analysis chart for the scientific specification and accurate shop record of hydraulic and pneumatic "U" packings has been prepared by Wayne Davies & Company, Chicago, Ill. The bulletin with the chart gives details on the hydraulic service improvements developed by Wayne Davies with data and information enabling maintenance engineers to determine requirements and dimensions for every condition, for easy record on the form that accompanies it.

The makers claim several advantages for the construction of the Davies Double "U," including selected leather of great uniformity; a double wearing wall and reinforced heel; leather in plies to resist absorption and wear; channel "U" section folded without lateral tension or fiber distortion; phosphor bronze finger springs for lip actuation, independent of pressure; and a white oak spacer to prevent shifting, rolling, or lip distortion.

Adhesive for Protecting Plastics

For protection of the polished optical surfaces of plastic enclosures by heavy masking paper against scratching and marring during the processes of manufacture and shipment, the development of a substitute for the crude rubber used in the paper cement was undertaken by the Plastics Department of E. I. du Pont de Nemours & Company at the request of the War Production Board, Army, and Navy. More than one hundred different adhesives, most of them compounded in du Pont laboratories, were tested during the search for a crude rubber replacement. The chemical and physical properties of virtually all synthetic rubberlike materials were examined.

The requirements for the adhesive were: to seal the protecting paper to the plastic throughout all operations to withstand extremes of temperature and humidity, and to strip off easily, but not self-strip, leaving no deposit of adhesive. Furthermore, the adhesive could have no chemical effect on the plastic and not cause frosting, crazing, swelling, or discoloration. It had to retain its adhesive quality for long periods; it could not curl up at the edges and peel in the sunlight or while the plastic was being cut, sawed, or drilled. It had to be reusable if the paper should be removed during heating and forming operations.

An adhesive meeting these requirements has now been developed by the company and approved by the Army Air Forces and the Navy. It is claimed that it actually stands up better than crude-rubber adhesive in sunlight and does not "crack off" from the plastic.

Cast Resin Delivery Container

A Durez casting resin is used for the drill jig in the production of the aerial delivery container for the Curtiss Caravan. This cast jig was made directly on one of the containers to assure a perfect contour. Since the Durez resin in its cured state has about the same consistency as hard maple wood, it is comparatively easy to saw and machine. Holes were drilled for bushing locating pins, and the bushings themselves were cemented into place with cerrobend—a low-melting-point alloy that expands when it solidifies.

The cast Durez resin has an impact strength of 0.11 to 0.15 ft.lbs. Izod and a compressive strength in excess of 20,000 lbs. per sq.in. Flexural strength is from 7,000 to 9,000 lbs. per sq.in. Shrinkage is 0.003 after a two-hour bake at 140°F. Use of this resin for jigs, fixtures, hydropress, and stretch press molds is reported to have released thousands of pounds of tool metal for other purposes. Durez Plastics & Chemicals, Inc., North Tonawanda, N.Y.

Flowmeters

A group of instruments for measuring the flow of liquids used in airplanes is described in an eight-page folder. The instruments are known under the trade name "Rotameters" and are used for measuring fuel flow rate—direct reading; fuel flow rate—remote reading; anti-ice fluid flow rate; oxygen flow rate; dynamometer fuel-consumption tests; and pump testing at overhaul bases.

Direct-reading fuel flow Rotameters installed in the airplane are mounted in a fume duct against a fire wall, directly back of which is the instrument panel. Doors with glass windows located in the instrument panels permit observation of the Rotameters and give easy access to the instruments when necessary. Capacity scales show flow rate both in terms of pounds per hour and gallons per hour. For observing and controlling the rate of flow of anti-ice fluid from the storage tanks to the propeller slinger rings, the Rotameters are flush-mounted against the instrument panel from the rear. Instruments are available for installations of one engine, twin engines, or four engines. In addition to these instruments for use directly on the airplane, Rotameters are widely used for measuring fuel consumption of aircraft engines on dynamometer test stands and at overhaul bases to check the operation of fuel pumps, lubricating wire stands, cooling fluid stands, and others. Fischer & Porter Company, Germantown, Philadelphia, Pa.

Aircraft Control Pulleys

An 8-page brochure contains drawings, tabulated data and specifications on control pulleys for aircraft. The data cover AN specification ball-bearing control pulleys and bronze-bushing type pulleys with graphite-bronze bearings. In addition, there is information on aluminum-alloy control pulleys with ball or roller bearings. General Aviation Equipment Company, Inc., Ashley, Pa

Indicator-Light Autotransformer

An indicator-light autotransformer for use on military and commercial aircraft has been developed by the General Electric Company.

Available in two models, the autotransformers weigh $13\frac{1}{4}$ oz. and measure $2\frac{1}{4}$ by $3\frac{1}{4}$ by $1\frac{1}{2}$ in. They operate at altitudes from sea level to 60,000 ft. and at temperatures from −40° to 140°F.

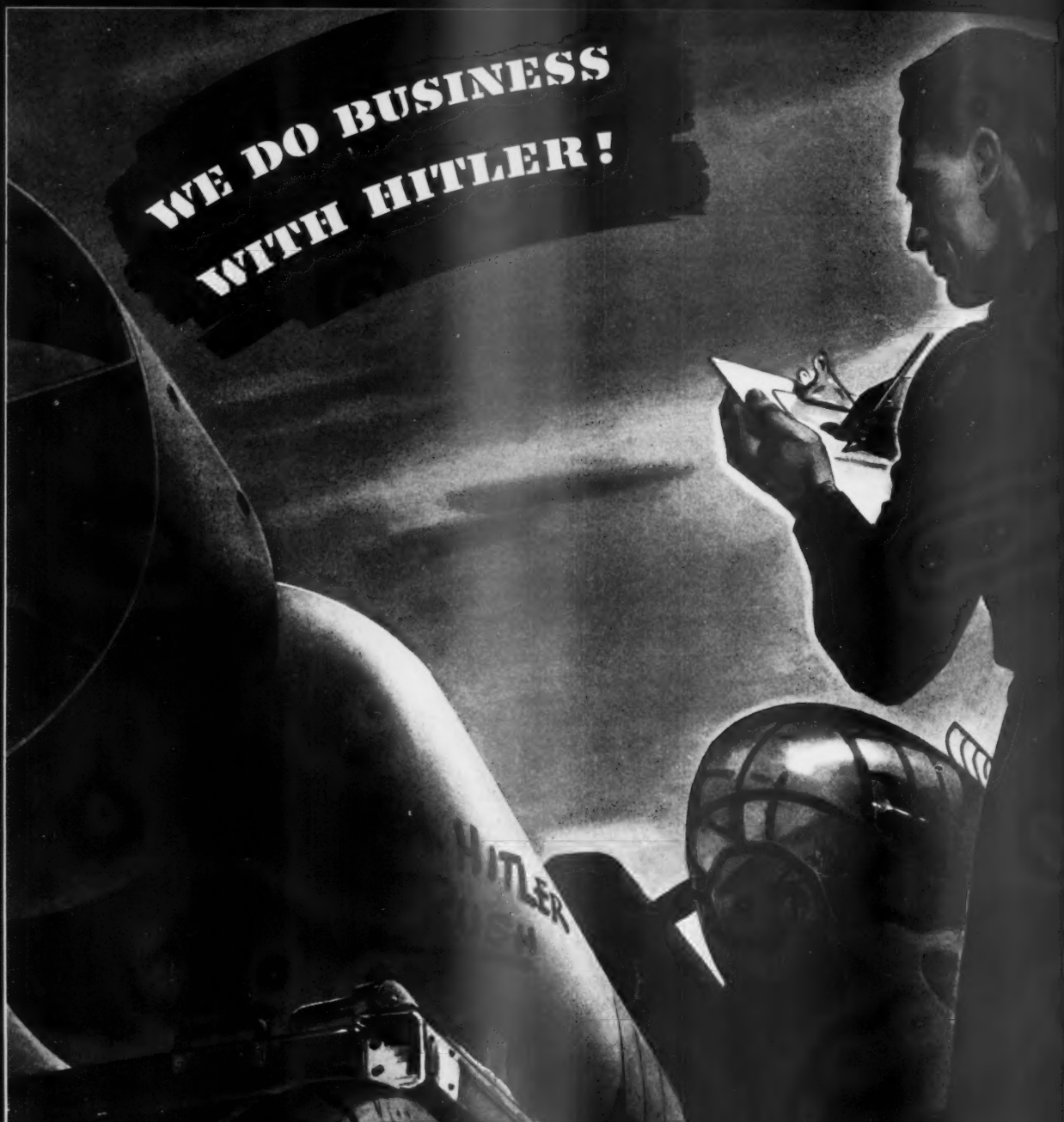
A 30-volt-amp. output at 3.01/1.5 volts—capable of operating 52 0.19-amp. T-$1\frac{1}{4}$ bomb-indicator lights—is furnished by either the 115-volt or the 26-volt model. Both models operate from a 400-cycle, single-phase supply. A 1.5-volt tap is provided for dimming the indicator lights, making possible reduction of excessive brilliance in cockpit lighting when desirable and preventing premature lamp failure due to overvoltage when only part of the lamps are lighted. The autotransformers conform to specifications of the U.S. Army Air Forces.

Sizing Reamer for Ball-Bearing Fits

An expandable sizing reamer developed at General Electric's Schenectady Works provides a repetitive production tool for reaming holes in ball-bearing housings. Because the tool is claimed to be reliable even in the hands of an unskilled workman, it has materially speeded the production of an important ordnance item. Holes bored 0.001 to 0.002 in. under size are finished with the reamer to a tolerance of between 0.0002 and 0.0003 in.

The tool is essentially an expansion reamer designed for a cut of about 0.0005 in. per turn. The company has many sizes in operation, ranging from $\frac{1}{2}$ to $6\frac{1}{2}$ in. in diameter. Some are being used on rabbet and hub fits and other male parts that require accuracy.

The reamer is provided with a micrometer setting adjustment with 50 equal divisions shown on the index dial. In setting up for production, the tool is first reduced in diameter and inserted into the bore of a trial piece. Then it is expanded and the proper index number on the dial is established for the finished tolerance. The reamer is



Who says "You Can't Do Business With Hitler"? Douglas A-20 Havoc and Boston attack bombers, Douglas Skymaster, Skytrain and Skytrooper transports *are doing business* with Hitler around the clock. It's a grim business that will increase in volume until our final victory is won. Douglas Aircraft Co. Inc., Santa Monica, Calif.

World's largest builder of cargo and transport airplanes.

PATTERNS FOR DOING BUSINESS WITH THE AXIS

C-54 "Skymaster" · C-47 "Skytrain" C-53 "Skytrooper" · A-20 "Boston" A-20 "Havoc" · SBD "Dauntless"

DOUGLAS

MEMBER, AIRCRAFT WAR PRODUCTION COUNCIL, INC.

then ready for use on regular production work.

Power Package for Aircraft

The G-E power package for aircraft, a coordinated unit consisting of electric motor, clutch, brake, gears, limit switch, and load release, is described in an illustrated 4-page bulletin (GEA-3968) recently issued.

The bulletin details the three types in which the compact power package is furnished and explains the use for which each type is designed, as well as the functions of the component parts. General Electric Company.

New "Ice Tires"

A new "winter tire" for aircraft, laced with steel coils to resist skidding on icy airport runways and in arctic and subarctic regions, has parallel rows of steel coils imbedded in the tread so that the edges grip on ice and snow.

The steel coils are bonded to the rubber around the circumference of the tire during vulcanization. A new method of tire construction had to be developed to accomplish the bonding. The B. F. Goodrich Company.

Goodyear Navy Fighter

The Goodyear FG-1, claimed to be the first Akron-built combat plane, is a Navy fighter plane produced from the design of the Vought-Sikorsky Corsair.

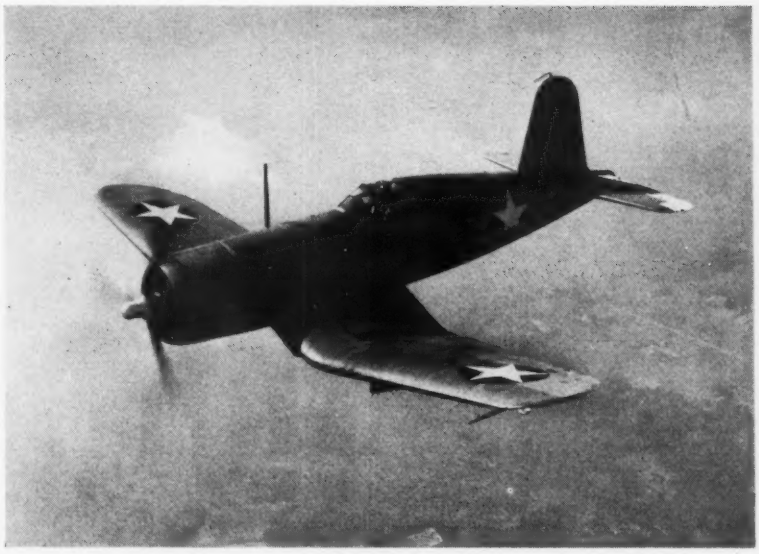
A single-seater fighter with high-speed, fast-climbing rate and high ceiling qualities, the FG-1 is powered by a single Pratt & Whitney double-Wasp engine of 2,000 hp. The plane has a wing spread of 41 ft., is a little more than 33 ft. long, and stands slightly over 16 ft. in height. Wings are of the folding type to facilitate its use aboard airplane carriers, and the wheels of the plane are retractable. Service ceiling of the FG-1 is placed at 35,000 ft.

With a speed indicated in Navy information as being "in the 400-m.p.h. class," the Goodyear-built FG-1 is stated to have a relatively low landing speed, enabling it to land on the decks of carriers or on hastily constructed airports in the advanced fighting lines and simplifying its operation when either land or carrier based. Goodyear Aircraft Corporation.

Non-Skid Tire

Designed to prevent skidding on snow and ice, a new type airplane tire whose tread comprises thousands of steel-wire spirals is now in production for U.S. Army planes.

In producing a tire of this type, the wire coils are strung on steel rods to be transferred in parallel rows to rubber mats. As the carcass is vulcanized, the thousands of wire coils become integral parts of the tread itself, scarcely noticeable in the tread when the tire leaves the mold. Goodyear Tire & Rubber Company.



Goodyear FG-1.

Plywood Tackers

A hand tool designed to facilitate the fastening of plywood panels in the assembly of aircraft and other applications is described in a 4-page folder. These tools are used to hold the plywood panels in place preparatory to molding. It is indicated that the tool can be operated at high speed with one hand, no power apparatus being required. A. L. Hansen Manufacturing Company, Chicago, Ill.

Vernier Height Gauge

Vernier height gauges in three standard sizes, 12, 18, and 24 in., English or metric measure, are announced by the Jansson Gage Company, Detroit, Mich., in addition to its line of precision gauge blocks; tri-squares; thread and cylindric plugs and rings; and a variety of special profile, snap, and flush-pin gauges.

The new Jansson height gauges are designed especially for use in jig and fixture making and for general layout and inspection work. They are precision calibrated, making these gauges valuable adjuncts to gauge blocks in angle measurement and other operations where unusual accuracy is required.

New Army Life Belt

A new device designed to guard the lives of U.S. troops aboard ocean transports is an inflatable life belt worn by the soldiers night and day and capable of keeping the soldier afloat almost indefinitely. Only slightly larger than a polo belt in collapsed form, the new lifesaver can be instantly transformed into a life preserver by means of an inflating device designed by engineers of Walter Kidde Company, Inc., Bloomfield, N.J.

Buoyancy is supplied by two small bullets of compressed liquid carbon dioxide similar to the cartridges used to charge home syphon bottles in peacetime. When released by a quick squeeze of a valve lever, the liquid expands 450 times its stored volume.

Tube-Forming Machine

A leaflet has been published describing a machine called the Tube Master which will square, burr, flare, and bead ferrous and nonferrous tubing.

The Tube Master is designed to speed up production by eliminating the need for hand tools and dies and is used by aircraft manufacturers. It requires but a few moments to prepare the machine for any of the various operations. Ten sets of flaring dies and centers, squaring and burring attachments are standard equipment of the unit for tubing $1/4$ to $1\,1/2$ in. outside diameter. Compact design permits installation where bench and operating space is at a premium. Leonard Precision Products Company, Garden Grove, Calif.

Indicator Operated by Reflected Light

The Littelfuse No. 1534 Signalette is a new signal indicator for use in aircraft wherever a signal light is required.

Indication by this unit is entirely by reflected light and radioactivity. The Signalette operates by fluorescence under "black light" from the usual sources within aircraft. A radium-active fluorescent paint used on the

INDIUM

Use It and Obtain These Advantages

- **Increase the Hardness of Non-Ferrous Metals**
- **Protect Surfaces against Wear**
- **Protect Surfaces against Corrosion**

WEAR AND CORROSION . . . two "gremlins" against which design engineers are ever on guard! Let these two fifth columnists loose in a plane and anything can happen.

Where non-ferrous metals are concerned, wear and corrosion problems are being solved by the use of INDIUM. It's the "vitamin" for *all* non-ferrous metals. A percent or two works wonders not only in protecting against wear and corrosion but in other ways. Bearings, plated surfaces, solders, contact points . . . these and many others have had their usefulness increased greatly by the addition of INDIUM.

The use of INDIUM should be investigated for *every* problem associated with non-ferrous metals. And it's an *available* alloying metal. We can supply both INDIUM Metal and INDIUM Salts in commercial quantities.

We'll be glad to have you write us about your problems.

ARMY E NAVY

THE INDIUM CORPORATION OF AMERICA Pioneers 49

The INDIUM *Corporation of America*

UTICA, N. Y.

New York Office: 60 East 42nd Street

indicator shows signals in total darkness. It draws only 1.5 watts.

The indicator was designed to eliminate the blur occasioned by transmitted light and to give clear visibility of signals. The pilot's eyes do not have to adjust to the reflected light. Indication is free from glare in daylight as well as in night use, and it is not dimmed.

The Signalette carries a transparent plastic cap intended to withstand severe tests of shock or explosion and to permit free penetration by ultraviolet rays.

The body of the indicator houses a solenoid, the armature of which is connected with "butterfly" indication vanes by a lever linkage. The "butterfly" opens instantly to show signals, reflecting the proper indicating light. "Butterflies" are furnished in red, amber, and green.

The Signalette was planned to be interchangeable with signal indicators (AC 42B3539) now used in the cockpits of aircraft. Its overall length is $2^{5}/_{32}$ in., for mounting in panels up to $^{3}/_{8}$ in. thick. Littelfuse, Inc., Chicago, Ill.

Aircraft Starter Unit

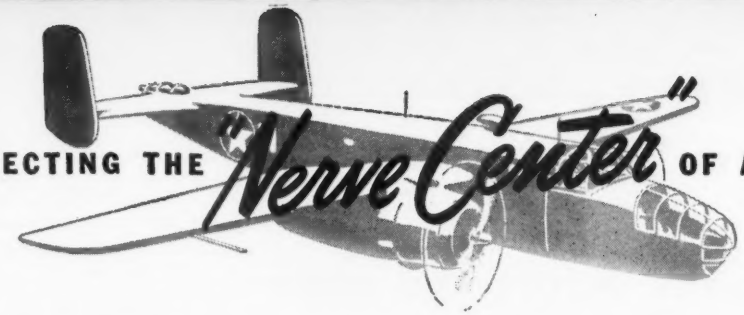
A new, portable aircraft starter unit, known as the Nite-Hawk "Aero-Start," has been announced by Lister-Blackstone, Inc., Milwaukee, Wis. It provides power for starting electrically started aircraft engines by simply plugging in to the control panel and, according to the manufacturer, delivers constant voltage during the starting cycle. An aircraft engine can be "rolled" continuously while installed in the plane or in the maintenance shop.

The outfit consists of a steel-housed, spring-mounted trailer unit in which is housed a direct-current electric generator that delivers up to 500 amp. at both 12 and 24 volts. Power is supplied by a 19-hp., four-cylinder, air-cooled gasoline engine, complete with electric starter. Tool boxes on each side of the assembly provide space for storage of cables, tools, and accessories. A pair of 24-volt floodlights, mounted on telescopic adjustable supports on the front of the "Aero-Start," supply light for night operations.

Work-Schedule Device

The "Shift-O-Graph," a graphic chart for work scheduling, offers a method of determining work schedules for a variety of work shifts. It consists of a disc on which schedules are laid out in concentric circles to cover each day of the week and one to three shifts per day. The disc is concentrically mounted in a cardboard frame in which two windows are cut, through which views are obtained of the schedule for three

Photo by Office of War Information



PROTECTING THE "Nerve Center" OF A B-25 BOMBER

The young lady is attaching terminals to the panel of an electrical junction box, shortly to become the "nerve center" for a big B-25 bomber. To protect against static interference, incoming and outgoing wiring is encased in Flexible Low-Tension Shielded Conduit made by American Metal Hose.

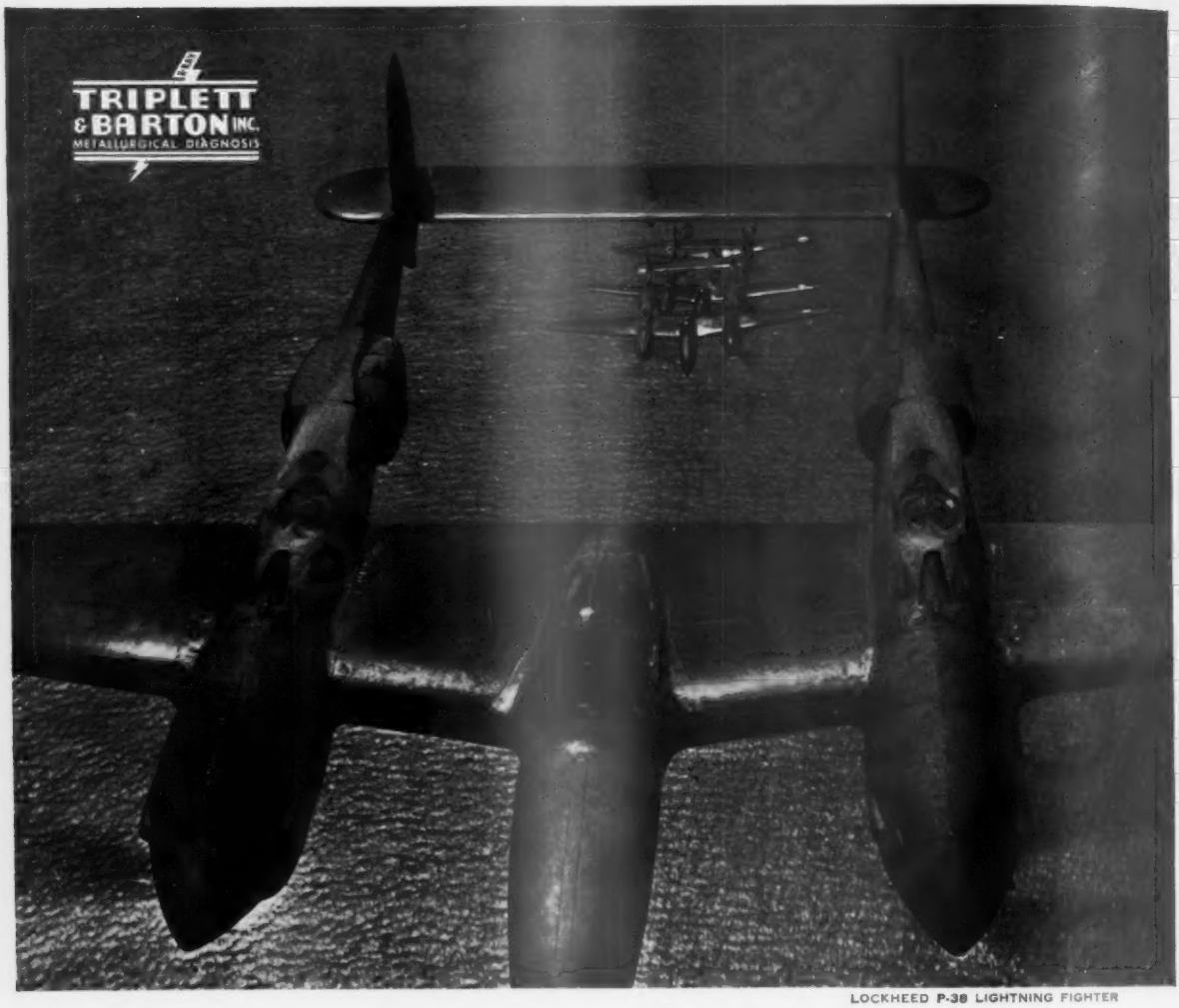
Wherever planes fly, this battle-tested conduit is playing its part in supporting brilliant performance... enabling radio signals and directions to come in clear and undistorted. It is one of the important "tremendous trifles" that are helping American wartime aviation set so many outstanding records.

American Metal Hose makes a complete line of fittings and accessories for American Flexible Low-Tension Shielded Conduit. Both fittings and conduit conform to A-N, A-C and NAF specifications. We are also prepared to make complete assembly of conduit and fittings to meet individual specifications, thus conserving valuable time on the production line for aviation plants. Inquiries will receive prompt attention.

43188

ANACONDA *American Metal Hose*

AMERICAN METAL HOSE BRANCH OF THE AMERICAN BRASS COMPANY • General Offices: Waterbury, Conn.
Subsidiary of Anaconda Copper Mining Company • *In Canada:* ANACONDA AMERICAN BRASS LTD., *New Toronto, Ontario*



LOCKHEED P-38 LIGHTNING FIGHTER

Lightning streaks across the waters

Death and destruction for the Axis is the air language of the Lightning P-38 fighter airplane. Over France and Germany, over Tunisia and in the Southwest Pacific and the Aleutians, Lightnings have proven tough for the foe. Versatility becomes the Lightning too . . . escort for Flying Fortress bombers, dog-fighter, ground strafer, medium attack bomber, long-range camera ship, interceptor.

The Lightning . . . a rugged, tough customer . . . and in fact, *all* American aircraft, owe much to the men and methods responsible for them. X-ray analysis is providing good insurance against structural failures and loss of machine-time . . . either of which must not happen now. Triplett & Barton X-Ray both castings and fittings of all the stress parts that go into this Lightning fighter. In fact *all* the Triplett & Barton laboratory services have contributed to its stamina and performance.

Pioneers in the use of X-Ray for determining the fitness of aircraft parts, Triplett & Barton offers its services to other essential industries as well . . . ship-building, armament, foundry, metals, plastics and plywood, and others. Consult Triplett & Barton specialized technicians about your metal problems . . . these services are available to you: X-Ray and Gamma Ray analyses—Physical and Electrical testing—X-Ray Diffraction—Chemical and Spectrographic diagnosis—Metallography—Heat Treatment and Foundry Sand Testing—Hi-Speed and Microphotography, and others.

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WICHITA, KANSAS • **BURBANK, CALIFORNIA** • SEATTLE, WASHINGTON **TRIPLETT & BARTON**

weeks at a time under different work schedules. By rotating the disc any one of four plans of activity can be carried out. The device is intended to help secure maximum operation of equipment. Instructions for the operation of the four plans are printed on the back of the frame. George S. May Company, Chicago, Ill.

Automatic Temperature Control for Evaporative Heat Exchanger

A new method of automatic temperature control for the Niagara Aero Heat Exchanger as used for cooling industrial liquids has been developed. This method is based on controlling the amount of outside air passed through the evaporative cooling chamber rather than altering the flow of liquid being cooled. It is stated that the cooling effect is directly proportioned to load changes, giving a modulated, nearly straight-line temperature control with no "hunting" action. Other advantages claimed by the maker are that water savings are increased and, when the heat exchanger is used to cool oils or compounds, there is no settling, refill restricted flow, or clogging of tubes to interrupt operations.

The apparatus comprises a recirculating air duct to which outside air is admitted by dampers controlled by a thermostat in the liquid line where it is always in contact with the full flow of the liquid being cooled. Only the minimum amount of outside air is admitted, keeping spray water temperature above freezing to prevent damage to equipment in cold weather.

With this automatic temperature control, the Niagara Aero Heat Exchanger is applied to cooling water, oils, solutions, compounds, coolants, chemicals, and process materials in such varied fields as heat-treat quenching; wire drawing; coolants for cutting, grinding, and machining; chemical process cooling; plastics; petroleum products; engine jacket water; air and gas compressor jackets; intercoolers and after coolers; transformers and motor generators; electronic apparatus; condensers; bearings; molds; hydraulic equipment; and process and power equipment. Niagara Blower Company, New York.

Report on Stainless Steels

Oakite Products, Inc., New York, has published a special service report titled *The Fabrication And Surface Treatment Of Stainless Steels*. Among the subjects discussed is the machining of stainless steel. After pointing out that galling and sizing are apt to occur unless special precautions are taken, the report describes effective tool-grinding practices and selection of the proper cutting lubricant. Formulas for lubricating "free machining" grades, as well as tough grades of stainless steel, are given. Rough and finish grinding, as well as deep drawing and forming operations, are also discussed, with particular emphasis placed on the important role played by lubricants and coolants.

Surface preparation is simplified by the proper application of specialized descaling and degreasing materials. Suggestions on removing lubricating compounds, heat-treating scale, shop dirt, etc., between manufacturing operations and before inspection and assembly are given.

Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Maintaining Gas-Welding and Flame-Cutting Tips

A timesaving method for maintaining brass or copper gas-welding and flame-cutting tips has recently been devised which is claimed to be particularly applicable to metal-working shops where a large amount of welding and cutting is done and where tips are reconditioned or handled on a daily basis.

With this new method 500 tips are cleaned in three hours, compared with the rate of about 200 tips in seven hours by the usual method. The new technique requires the time of only one worker instead of four. The sequence of steps is as follows:

Tips are placed in a basket and immersed in a boiling cleaning solution for from 45 min. to one hour, followed by cold rinse. Next, tips are immersed in solution of Oakite Compound No. 32 to remove carbon, slag, and scale deposits, followed by cold rinse. Tips then are given a 10-min. bright dip followed by cold rinse and boiling rinse to dry down with final air blow. This sequence of operations takes approximately 90 min. after which tips are free of deposits that upset flame balance. The possibility of mechanical injury to tips is avoided and the tips come out of solution clean and bright. Oakite Products, Inc., New York.

Smithsonian Exhibit of Brushing Wheels in War Production

Approximately 70 distinct types of brushing wheels have been assembled for a permanent exhibit in the Smithsonian Institution at Washington by The Osborn Manufacturing Company of Cleveland, O., to show the uses of these products in the brushing of metals and other materials.

The exhibit traces the development of brushing wheels during the last 50 years and reflects the growth of industry to the present. Thousands of uses for brushing wheels have been evolved since then, and great numbers of them have been called into service as secondary machine tools to add surface finish after a precision lathe, planer, miller, or shaper completes its job.

The brushes exhibited are in three general forms—radial, cup, and end brushes. They are rotated on chucks, headstocks, grinding heads, power hand tools, or flexible shafts. The exhibit is assembled on two panels erected in a glass case. On one panel is a row of Tampico fiber wheels ranging in diameter from $3\frac{1}{2}$ to 14 in.

One unusual brush is made of pliccord for working in acid in the pickling of copper and brass. Another is a wheel of horsehair to produce an extra-fine finish on certain metals. A specially treated cord brush removes molding "fins" from plastics. A helical brush made of horsehair and fine wire is used to clean small-caliber guns.

On the other panel is a wide variety of brushing wheels. Some of these, containing heavy wire, are designed for exceedingly tough jobs, such as cleaning of welds. One has wide use now in the retreading of tires. A wide-face wire brush is used to remove sand particles from castings.

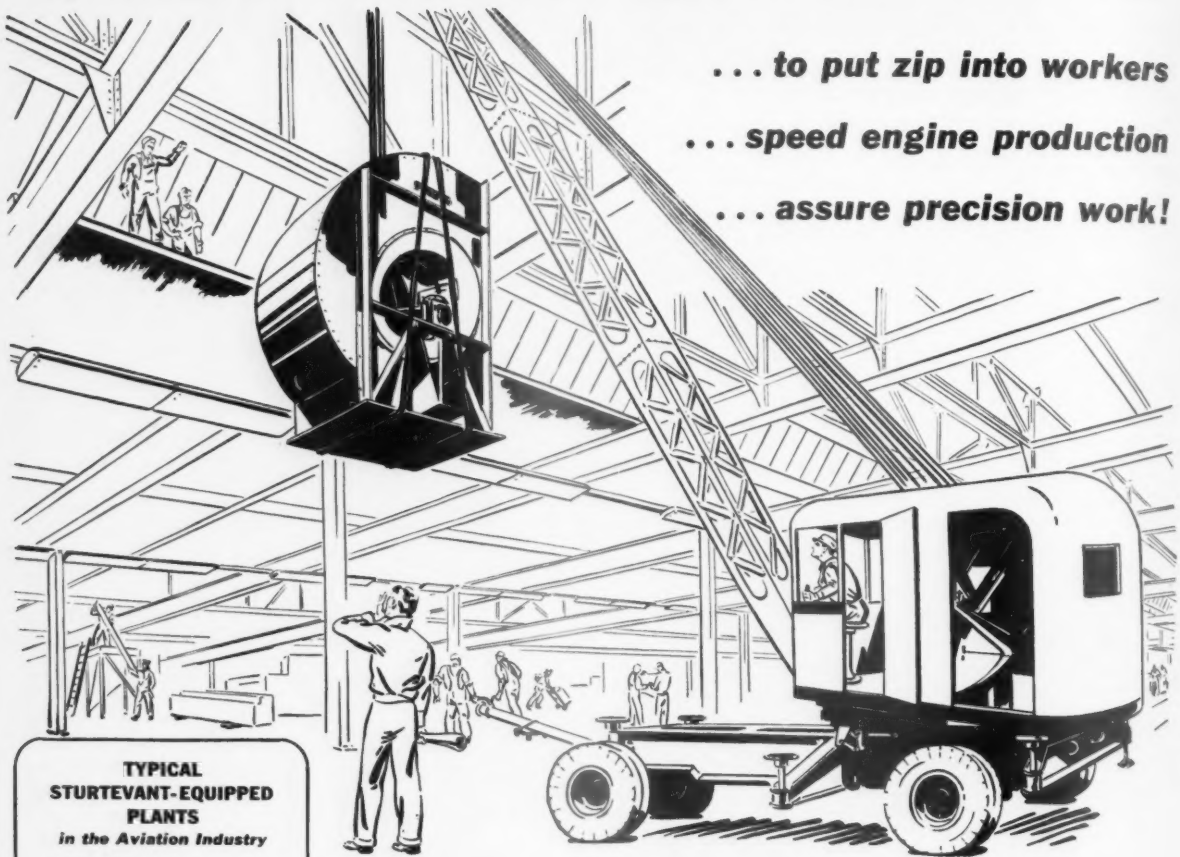
Steel Tray Substitutes

To conserve steel for war production and to make work lighter for its increasing number of women employees, the Pratt & Whitney Aircraft Division of United Aircraft has developed wooden containers as substitutes for steel trays now generally used for parts in process. It is claimed that the new type is easier to lift, is easier to clean, and has as long a service life as the standard metal tray.

The new tray has metal-bound wooden sides and ends and a plywood bottom that can be replaced when necessary by withdrawing eight rivets. Box grade $\frac{3}{16}$ in. hardwood plywood which is not on the critical materials list, and scrap metal salvaged from punch-press operations are used. The metal corner bindings are turned under the bottom for strength. Metal buttons that allow the trays to be stacked without danger of falling or slipping are on the ends of skids that extend under the four sides. Hinged metal handles and wooden or corrugated cardboard partitions to fit different parts complete the design.

7,000 TONS OF AIR an hour

. . . to put zip into workers
. . . speed engine production
. . . assure precision work!



TYPICAL STURTEVANT-EQUIPPED PLANTS
in the Aviation Industry

- Bendix Aviation Corp.
- Boeing Aircraft Co.
- Brewster Aeronautical Corp.
- Curtiss-Wright Corp. (3 plants)
- Curtiss-Wright Propeller Div.
- Fairchild Engine & Airplane Corp.
- Firestone Rubber & Latex Prod. Co.
- Ford Bomber Plant
- Ford Engine Plant
- Goodyear Aircraft Corp.
- Marietta Bomber Plant
- Glenn L. Martin Co. (3 plants)
- Studebaker Aircraft Engine Co. (2 plants)
- Wright Aeronautical Corp. (2 plants)
- United Aircraft Corp.
- Pratt & Whitney Div.
- Hamilton Standard Propeller Div.
- Numerous Naval Air Stations and Lighter-Than-Air Bases

50 ACRES within the walls of a single plant! That's the kind of air handling job that Sturtevant takes in stride. Calling for 161 giant fans like that shown above to supply and exhaust 3,203,400 cubic feet of air per minute—*more than 7000 tons per hour*—in the Wright Engine Plant at Cincinnati.

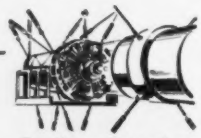
Precision plant air, supplied by Sturtevant here and in hundreds of other war plants, means closer tolerances in machining; healthier, more energetic workers; a clean, dust-free plant; ideal indoor weather—*all day, every day*—regardless of outside conditions.

And air conditioning is just one of the problems that Sturtevant Engineers are solving for the aircraft industry . . . supplying *engineered air*—for carburetor testing and for cooling engines on test; air that controls hazardous dust and fumes; humidifies and dries plywood; conveys shavings; heats large drafty areas...in short, steps up production wherever aircraft and their components are made.

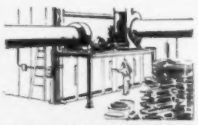
Do you face a particular problem that Sturtevant can help solve? With 83 years of air engineering experience, we are in a position to work closely with aviation engineers who are producing the planes for today or designing them for tomorrow.

B. F. STURTEVANT COMPANY
Hyde Park Boston, Mass.

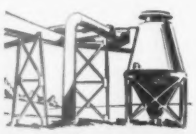
Sturtevant
REG. U. S. PAT. OFF.
Puts Air to Work



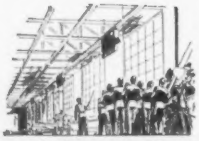
Fans for cooling engines on test blocks



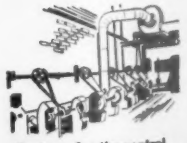
Dryers for plywood and other materials



Pneumatic conveyors for sawdust, metal shavings, etc.



Units or systems for Heating and Ventilating



Systems for the control of Dust and Fumes

Resistance Welders

A line of "press" or "projection" type resistance welders was recently announced by Progressive Welder Company, Detroit, Mich. The group of standard machines comprises four basic types—light duty, medium duty, heavy duty, and extra-heavy duty. Each type if available in capacities from 4 to 6 kva. and a variety of throat depths.

Each model is made in either air-operated or motor-driven style, while extra-heavy models are also produced for hydraulic operation. Each capacity range has a single basic frame designed to accommodate the heaviest duty model in that particular range, thus permitting ready conversion to higher or lower capacities within the duty range when required. All models are fitted with universal T-slot platens for ready mounting of fixtures and dies. Knees of machines are vertically adjustable to permit setting for various throat openings desired for different jobs. All models are fitted with double cooling water manifolds in the base of the machine. These are provided with a series of outlets to permit connection of up to six die-cooling circuits to suit individual requirements. Platens are also water cooled.

The new press welders are designed for 50/60 cycle supply and 220, 440 or 550 volts, as standard. They are also available on special order for other frequencies.

Ultrasensitive Multitester

A new ultrasensitive multitester, known as Model 461, has a sensitivity of 20,000 ohms per volt on all d.c. scales. The sensitivity on a.c. scales is 1,000 ohms per volt. Measurements as low as 1 microamp. are possible on the 100 microamp. scale. Meter movement is 50 microamp. Shunts and matched-pair metalized voltage multipliers are designed to be accurate to within 1 per cent.

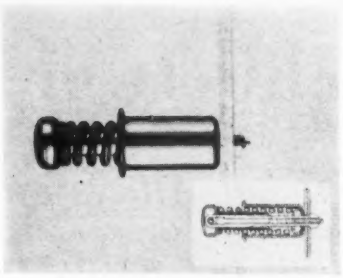
The multitester has the following ranges in its different capacities: as a d.c. or a.c. voltmeter, 0 to 5,000; as a d.c. microammeter, 0 to 100; as an ohmmeter, 0 to 10,000,000; as a decibel meter, −10 to +50.

Overall dimensions of the Model 461 are 7 by 3 in. The instrument is furnished with self-contained battery supply. Radio City Products Company, Inc., New York.

New Skin Fastener

"Loxit," a new type of aircraft skin sheet fastener, is reported to have a high factor of safety, to reduce workers' fatigue, and to speed operations.

In use, the new skin fastener is grasped lightly in any standard skin-fastener plier. The wedge is inserted in the skin sheet hole where it acts as



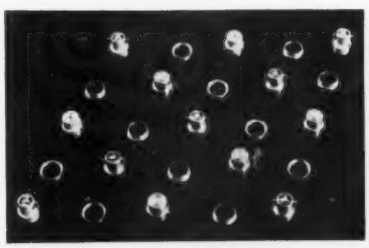
"Loxit" skin sheet fastener.

leader, lining up the holes in the skin sheets. The fastener is then compressed and locks into place with a clearly audible "snap." The fastener is claimed to fill the rivet hole, preventing lateral skin motion in any direction. Vibrations of riveting do not loosen them, since the center wedge action applies the centering force evenly in both directions. The coiled tension spring automatically compensates for various sheet thicknesses.

Additional features of the new skin fastener include a new "tubular sleeve" that reinforces and guides the plunger. Heat-treatment of the case increases the fastener's resistance to plier wear. These fasteners are currently available in sizes for $^3/_{32}$, $^1/_8$, $^5/_{32}$, and $^3/_{16}$ in. diameter holes, and the majority of parts used in these various sizes are interchangeable. Scovill Manufacturing Company, Waterbury, Conn.

Spiral Countersinks

Refinements in the design and manufacture of spiral fluted countersinks and counterbores are reported by Schrillo Aero Tool Engineering Company, Los Angeles, Calif. The design of the spiral is claimed to permit sinks to be sharpened repeatedly without sacrifice of cutting efficiency. Both countersinks and counterbores have hardened and ground shanks that are unaffected by chucks or wear. It is stated that the special spiral design of these cutters results in superior chip clearance. In addition to an extensive line of cutting tools, the company also makes precision plain and thread plug and ring gauges.



Simmonds TA "quick release" clips and rings. The TA clip is a special semi-automatic fastener that is engaged and disengaged speedily without the use of special tools. The locking of the clip depends on two separate springs, each controlling a pawl, operated by a plunger that can be moved with a finger. The clip locks automatically when pressed into the mating ring.

Wire-Stitching Machines

Specifications and features of Morrison wire-stitching machines for aircraft assembly work are set forth in a folder that contains illustrations of the machine and its various parts, together with descriptions of the work for which it is designed Seybold Division of Harris-Seybold-Potter Company, Dayton, O.

Tubing Purchasing Manual

A manual has been prepared by representatives, comprising metallurgists and technicians, from a group of manufacturers of aircraft tubing. The information is based on an analysis by these tubing manufacturers of a record of all orders received by them for the first ten months of 1942. The chart indicates that 95$^1/_2$ per cent of the total footage ordered from all mills was for the sizes shown on the chart. The data cover standard sizes of alloy seamless aircraft tubing of outside diameter ranging from $^3/_{16}$ to 3 in. and standard sizes for X-4130 welded aircraft tubing in sizes from $^3/_8$ to 1$^1/_8$ in. Explanatory notes accompanying the charts give definitions and instructions for placing orders. Summerill Tubing Company, Bridgeport, Pa.

Compressed Air Used in Testing Speed Nuts

Tinnerman Products, Inc., Cleveland, O., applies a test involving 3,000,000 sharp jolts for the self-locking speed nuts which the company produces for airplanes and other war machines of the United Nations. Occasionally, more severe tests are made—as many as 10,800,000,000 vibrations.

The testing machine, developed by the company, uses an air hammer to vibrate a steel bar about 2 ft. long and 2 in. wide. The bar is clamped onto the piston of the air cylinder, and the nuts are fastened onto plates carried by the metal bar. The armature carrying the speed nuts under test is vibrated by the air cylinder at an amplitude of $^1/_{16}$ in. The frequency of the vibration is measured by a vibrometer and adjusted to 3,500 cycles per min. The tests are run on an average of 35 hours, but some are conducted as long as 1,000 hours.

Compressed Air Solves Two Problems

Compressed air is reported to have two annoying problems in production at Tinnerman Products, Inc., Cleveland, O. In the process of making self-locking speed nuts, conduit clamps,

AT SUB-ZERO TEMPERATURES

the INCO Nickel Alloys gain strength without becoming brittle

MECHANICAL PROPERTIES AT LOW TEMPERATURES

MATERIAL	Condition	Temperature °F.	Yield Strength (0.20% offset) psi.	Tensile Strength psi.	Elongation in 2 in. per cent	Reduction of Area per cent	Hardness Rockwell C	Charpy Impact Strength ft.—lb.
MONEL	Cold-drawn	Room	93,700	103,800	19.0	71.0	19	181
		—110	100,850	117,450	21.8	70.2	25	178
"K" MONEL	Cold-drawn Age-hardened	Room	125,900	157,300	15.5	37.4	33	27
		—110	134,600	171,550	17.3	41.1	36	27
INCONEL	Annealed	Room	36,800	93,800	37.3	64.1	82B	130
		—110	42,400	106,450	39.8	64.0	87B	134
	Cold-drawn*	Room	147,700	152,100	7.0	49.3	31	54
		—110	154,900	163,900	9.8	51.2	36	60
NICKEL	Cold-drawn	Room	97,400	103,400	16.3	66.9	19	204
		—110	101,800	112,300	21.5	60.9	22	215

*50 per cent reduction in cross-sectional area by cold drawing.

Selecting the right metal for a given application is today more important than ever.

How drastically the possibilities narrow down is exemplified by *sub-zero* requirements.

At sub-zero temperatures, for example, most ferrous metals become brittle as their strength increases. INCO Nickel Alloys also increase in strength and hardness...but they retain room-temperature ductility and toughness as measured by Charpy impact tests (see table above).

Even at the —328° F. encountered in liquid air compressors, the INCO Nickel Alloys show no appreciable changes in elongation, reduction of area or hardness.

Also, "K" Monel retains another important property, non-magnetism...magnetic transformation point of this age-hardened alloy being —150° F.

A new technical insert, "Mechanical Properties at Low Temperatures" and the booklet "Individualized INCO Nickel Alloys" offer useful information. For copies of each write to:

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

★ ★ ★ ★ ★ **INCO NICKEL ALLOYS** ★ ★ ★ ★ ★

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL

Sheet...Strip...Rod...Tubing...Wire...Castings

and similar products from metal strip, a means had to be found to separate the long strips of paper which are rolled up with the strips of stainless steel to protect the steel surfaces.

The company found that when the stainless steel was fed into die presses there was no convenient way of discarding the paper. Mechanics at the plant devised a compressed air blow gun that works as follows:

As the metal is started off the roll and fed into the die-stamping machine, the end of the paper is fed into the "barrel" of the gun, which is made of 3-in. pipe about 2 ft. long. Into the barrel is inserted the open end of a pipe about 1 in. in diameter, carrying a current of compressed air. The air is blown into the barrel in the same direction that the paper travels so that, as the metal is fed off the roll, the air pressure keeps feeding the paper through the gun barrel. As the paper travels through, it falls into a wastepaper basket.

The other problem was the separation of the speed nuts after they are lacquered. The lacquer is sprayed onto the nuts inside a revolving barrel and, in the course of drying, many of the small, light pieces of metal adhere. Separation of these was a time-consuming job; therefore a gun similar to the other was devised. It had a "barrel" of about the same size with the outlet of the compressed air pipe—in this instance, a few inches from the mouth of the gun barrel.

The nuts are dumped onto a tray on top of the apparatus and are permitted to drop into the air stream a few at a time. They are immediately blown through the gun by the air current at approximately 90 lbs. pressure and shot against a heavy wire screen at the other end of the apparatus. Hitting the screen, they break apart and fall into a basket.

Torque Wrench

A new snap-acting torque wrench that gives both an audible and a physical signal when the proper predetermined torque load is reached is offered by Tubing Seal-Cap, Inc., Los Angeles, Calif.

Sold under the trade name Livermont Torq-Snap this new wrench requires no visual attention to operate since there are no dials or indicators involved. Upon reaching the desired predetermined torque load, the wrench gives a high-pitched audible "click" accompanied by a definite physical sensation transferred to the operator's hand.

Designed primarily for applying the proper torque load to tubing "B" nuts in aircraft plumbing, the Livermont Torq-Snap is claimed to eliminate the danger of pinching off or weakening flares, thus reducing the possibilities

The new Livermont torque wrench.

of failures in aircraft hydraulic systems.

The wrench works on the principle of a spring bar deflection. The deflection in the main bar bends a secondary spring that snaps over center when the proper load for which the wrench is preset has been reached. This causes a slight drop in the torque curve, makes a "click," and actuates a "button" in the handle giving a physical signal in the palm of the operator's hand. This double indication not only provides two warnings but also makes it practical to operate the wrench in restricted areas where indicators or dials could not be seen.

Twelve sizes will eventually be available with open or box ends, either offset or straight, for a wide variety of additional uses such as engine base, cylinder head and connecting rod bolts, spark plugs, wing and break attach bolts, and other bolts requiring a predetermined torque load.

Vega Ventura for the Navy

Equipped especially for operations against enemy submarines, Vega's first Navy warplane is a nautical version of the Ventura bomber which the company has been delivering to the Army and the British. Its Navy designation is PV-1.

Unlike the British Ventura, however, the Navy craft is not primarily a bomber. Carrying either depth charges or a standard torpedo, this land-based Navy plane is intended to destroy enemy submarines or surface craft. It was designed to fill the Navy's needs for twin-engined, land-based patrol aircraft with adequate range, in addition to both defensive and offensive armament.

Exact performances may not be given, but it is reported that the Ventura will fly farther than the Hudson with a heavier useful load and with a cruising speed approximating the top speed of the Hudson and that it has an enlarged bomb bay for accommodating the depth charges and torpedoes. In addition, it carries more radio equipment than any plane Vega or Lockheed have ever built.

The Navy's Ventura is powered by two 2,000-hp. Pratt & Whitney engines. Droppable gas tanks are fitted as well as tanks within the fuselage.

The Ventura normally carries a crew of four. It has a wing span of 65 ft. 6 in. It is heavily armed by machine guns protecting all vital points and in the nose for attack purposes. The plane will land at less than 80 m.p.h. Vega Aircraft Corporation.

Collating Machine

The Methods and Controls Department of the Nashville Division of Vultee Aircraft, Inc., has found a solution for the problem of lost time in collating or gathering numbered sheets. A mechanical collator developed at the Nashville plant now gathers approximately 360 sheets per minute compared with the old rate of 75 by hand.

The collator has a gathering capacity of twelve sheets in two groups of six each. The machine takes legal size paper ($8^1/_2$ by 14 in.) and has an adaptor for standard $8^1/_2$ by 11-in. sheets. The twelve bins each have a sheet capacity of approximately 500 letter-size sheets. The bins are constructed in two semicircular tiers with their planes conforming to the radius of a circle and their open ends toward the center where they may be grasped by the operator and withdrawn from the machine.

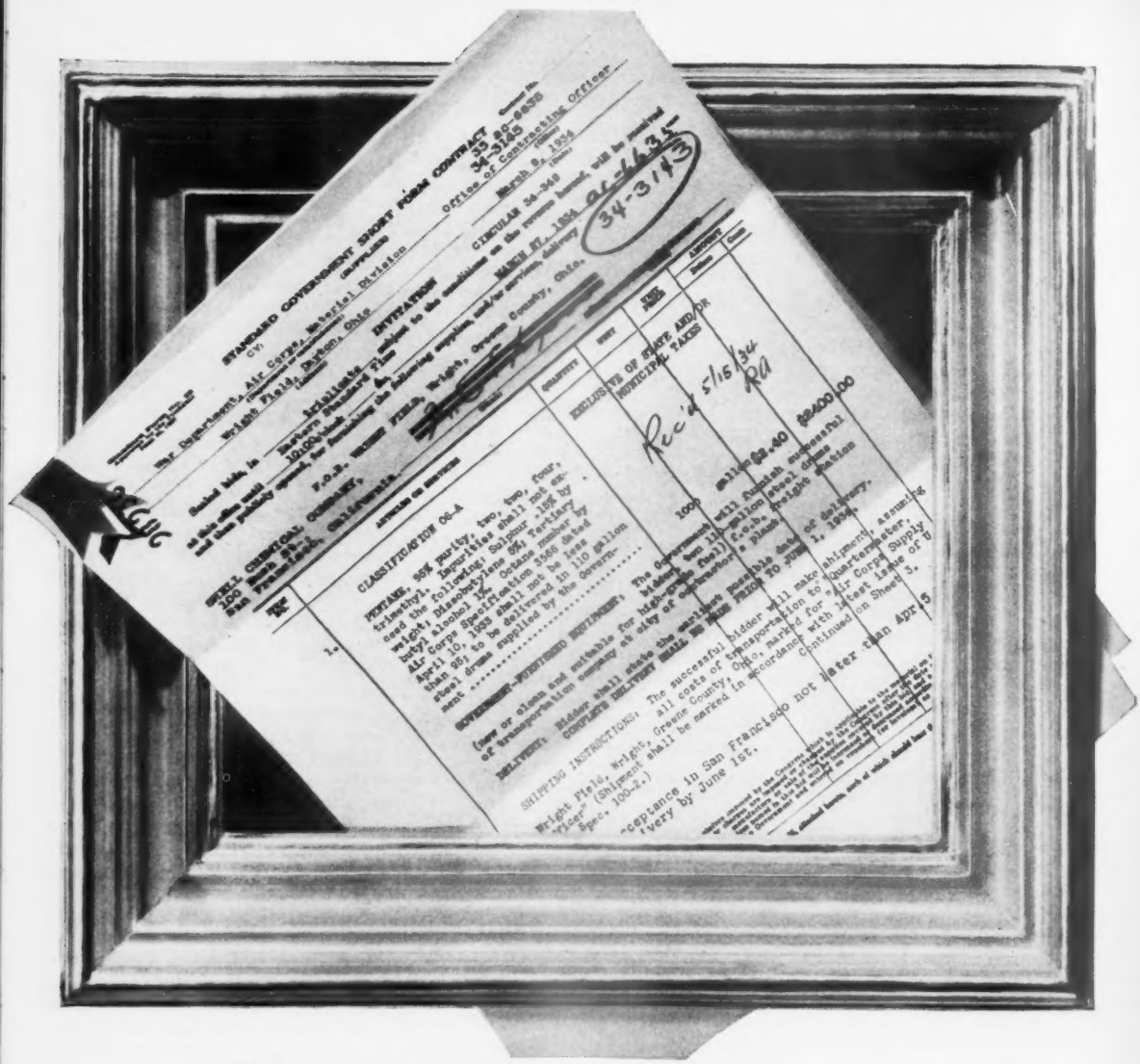
Spring-mounted feed arms equipped with soft rubber friction fingers are attached to the transverse slide rods within each bin so that they make contact with the centers of the paper stacks with a light downward pressure sufficient to move one sheet from each stack on the outward radial movement of the assembly.

Since each stack of sheets is retarded by gravity toward the back of the sloping bins and since the gripping action of the soft rubber feed fingers, with a light contact against the sheet stack, is greater than the dragging friction between sheets, the tendency is for a single sheet to slide forward from the top of each stack, while the under sheets either remain stationary or lose enough ground on the forward motion to drift back by gravity toward their starting position.

For reloading, a back pressure on the heel of the foot pedals causes the feed arms to raise above the feeding position allowing clearance room for new stacks to be inserted in the bins.

Booklet on Electrical Aircraft Instruments

Prepared especially for use in student training, a booklet entitled *Electrical Aircraft Instruments* has been published by Weston Electrical Instrument Corporation, Newark, N.J. The first two chapters of this booklet cover electrical circuits and electrical instruments in general. Following chapters deal with various types of electrical flight, engine, and radio instruments including circuit diagrams, curves, parts illustrations, etc.



"YOU OUGHT TO FRAME IT"

IN RESPONSE to the above historic order for fuel "not less than 95-octane," Shell's Research Laboratories did the "impossible" —supplied the U. S. Army Air Corps with 1,000 gals. of Iso-octane, to make the first 100-octane aviation fuel ever produced in a commercial quantity. Fuel that has given our air arm added punch, extra reach.

Although the quantity of 100-octane fuel turned out by all American refiners has been greatly multiplied since Pearl Harbor, Shell is maintaining its former position in the total production.

In fact, the majority of the country's leading plane and engine manufacturers are using Shell Aviation Fuels. Preference for Shell Aviation Products prevails among many aviation training schools, transport lines and airports.

Farsighted airport operators will find Shell's wartime popularity a profitable peacetime asset.

AVIATION FUELS SHELL **AEROSHELL OILS**

Institute News

$111,000 Given to the Institute

Glenn L. Martin, in accordance with his plan to create the Minta Martin Aeronautical Fund, gave to the Institute the second 5,000 shares of stock of The Glenn L. Martin Company having a current market value of $105,000. This gift will be added to a similar amount presented last year. The income from this fund may be used for the development of the Minta Martin Aeronautical Laboratories at Daniel Guggenheim Park, Sands Point, Long Island, or for other purposes if necessary. In addition to the above gift, the Institute received $6,000 in dividends in 1942 from the stock that it held in The Glenn L. Martin Company.

Paul Kollsman also added $6,250 to The Paul Kollsman Library Fund, making the total fund now $58,750. The income is used to maintain The Paul Kollsman Library of the Institute.

Major Lester D. Gardner (*left*) accepting from Glenn L. Martin 5,000 shares of stock of The Glenn L. Martin Company.

Financial Policy of the Institute

As the Institute now has ever increasing funds to administer, the Council decided that its financial policy should be clearly stated so that past and future donors may be assured that any funds entrusted to the Institute will be safeguarded.

A Finance Committee has been appointed. Its members are: Earl D. Osborn; Charles H. Colvin; Elmer A. Sperry, Jr.; Allan D. Emil, Attorney of the Institute; and Cole Younger, Vice-President of the Chase National Bank.

The Chase National Bank Investment Service Department has been retained as investment counsel. The stocks owned by the Institute will be under the supervision of experienced financial advisers who render a similar service to universities and many charitable funds. The Finance Committee will consider suggestions as to changes in the portfolio of stocks owned by the Institute and make such investments as in their opinion are to the advantage of the Institute. This procedure eliminates the necessity for the Council or any committee to make other than confirming opinions as to investments. The bank will also act as custodian of the stocks held by the Institute.

The Institute is following the procedure of other nonprofit organizations as to its investment policy and hopes that its conservative methods of handling funds presented by generous donors will give assurance that any future contributions will be given every protection. Every fund that has been given to the Institute is now worth more than when the gift was made.

Columbia University to Use Minta Martin Aeronautical Laboratory

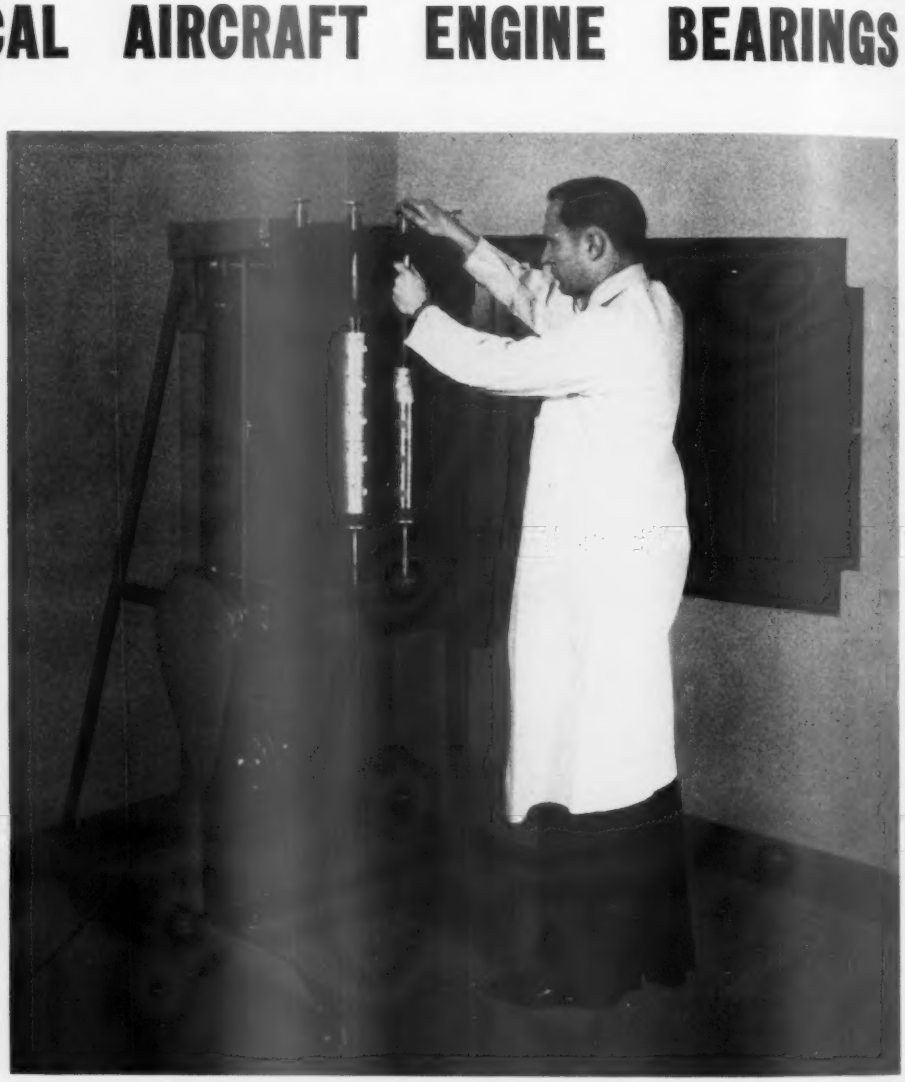
Columbia University has joined the Institute of the Aeronautical Sciences in the development of an aeronautical center at Sands Point, Long Island. The University will use the Minta Martin Aeronautical Laboratory building for research work and the Institute will organize an aeronautical library and museum. The property was given to the Institute last year by Mrs. Daniel Guggenheim in memory of her husband who endowed many aeronautical schools.

The plan of the Institute to establish an aeromedical laboratory has been postponed until the medical specialists required to undertake such research work are available. The Air Forces of the Army now require the services of this class of doctors for flight surgeons and high-altitude research.

The library will be a branch of the endowed Paul Kollsman Library of the Institute which loans, without charge, aeronautical books by mail to over 3,000 persons in all parts of the United States.

The museum will assemble an interesting collection of pictures, airplane models and interesting relics of famous flights. Eventually, the Institute plans to establish laboratories

Here's FAST, ACCURATE X-RAY INSPECTION of CYLINDRICAL AIRCRAFT ENGINE BEARINGS



ARMY E NAVY

● A fast, accurate routine method of inspecting cylindrical aircraft engine bearings is provided by the G-E Bearing Mandrel Cassette. With this unit the total inspection time required to completely x-ray 20 bearings has been reduced from approximately five hours to about 10 minutes. And in addition to its speed, the unit also provides substantial savings in both film and film-handling costs.

Accurate inspection is assured because the loaded mandrels are rotated 360° by an electric motor drive so that the entire surface of the bearing is exposed to x-radiation during the exposure. Thus the film gives the operator a full view of the uniformity of the internal metal content of the bearing.

The G-E Bearing Mandrel Cassette is but one of several cost-cutting x-ray inspection accessories designed expressly for use by the aircraft industry. Other G-E equipments include a semi-automatic x-ray unit for production line inspection of light metal castings, and x-ray matte transfer units for fast, accurate reproduction of full-scale exact-size templates directly on the material to be fabricated.

Like all other G-E Industrial X-Ray Units they are backed by more than 20 years' experience in the design and construction of industrial x-ray apparatus for all types of applications.

For complete details call in an experienced G-E Industrial X-Ray Engineer. You can rely upon him to give you facts and figures that will save your time, insure peak production inspection, and help you protect your x-ray investment. G-E's Industrial X-Ray Engineers have had wide experience in helping solve inspection problems in the aircraft industry. To request an engineer to call, or for additional information, write or wire, today. Address Department N 84.

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Today's Best Buy — U. S. War Bonds

for research and enlarge its library and museum when individual transportation facilities again become normal. A local committee at Port Washington will supervise the Institute's Library. The members are: Reginald Cleveland, *New York Times;* Henry Alker, President, Port Washington National Bank and Trust Company; Charles N. Wysong, Attorney; Lee Warrender, Casey Jones School of Aeronautics; Leroy R. Grumman, Grumman Aircraft Engineering Corporation.

Other Gifts to the Institute

Mr. Charles Colvin has presented a station wagon for use of the Institute at its Sands Point property. As the transportation problem is critical, the availability of this automobile will render a great service in the creation of the library and museum in two buildings on the property.

The veteran balloonist, A. Leo Stevens, is making the Archives of the Institute the repository of early clippings and papers relating to ballooning during the early years of this century. They make valuable additions for historical reference, since few people did more to stimulate an interest in lighter-than-air development than Mr. Stevens.

The biographic files of the Archives now have over 16,000 sketches of persons who are or have been engaged in aeronautics. This file was added to by James Peneff, Director of the Writers Project of the W.P.A. in Chicago, who sent the 8,000 original questionnaires received for the compilation of *Who's Who in Aviation.* Max Karant, editor of *Flying,* was most helpful in securing this valuable collection.

Warren McArthur presented to the Institute for use in the office of the Executive Vice-President a seat such as is used on air transport aircraft. It has all of the adjustable features of the most comfortable chairs yet devised for any transportation service.

William Waite gave a large flag used at the National Airplane Races held at Selfridge Field.

Mrs. Bella C. Landauer presented a very early hatbox such as was used by ladies early in the last century. It is covered with interesting balloon prints and adds another curious item to the Archives collection of Americana.

Dr. Lyman J. Briggs presented six copies of the rare volume, *Internal Work of the Wind,* by Dr. S. P. Langley.

Thompson Products, of Cleveland, in addition to the art calendars with reproductions in color of historic flights, presented a set of twelve plates decorated with colored pictures of early historical airplanes.

The Archives now has an interesting collection of aeronautical china. When Gen. E. M. Maitland was killed in the collapse of the British Airship R 38, he left a set of Spode China dishes. On each dish is painted a famous historical aeronautical scene. The set was bought by Dr. J. C. Hunsaker when he was serving as Naval Attaché in London. The Institute is fortunate in having been able to add this interesting set to its collection.

As Stanley H. Evans, of San Diego, has left for service abroad, he sent to the Institute a large and valuable collection of N.A.C.A. reports and over 200 clipped magazine articles.

At this season of the year, beautiful art calendars are received from many companies. For several years the Archives has been saving aeronautical calendars and now has probably the largest collection in this country.

The British Air Ministry has sent several hundred copies of the translations it has made from foreign aeronautical magazines. A list of these translations is being prepared so that they will be available for members of the Institute.

Harry Dichter presented several new musical compositions. The Robbins Music Corporation and The Sam Fox Publishing Company also sent several songs. The collection of aeronautical music, presented by Mrs. Bella C. Landauer to the Archives, is unique. Almost a complete pictorial history of aeronautics can be secured from the lithographed pictures on the covers.

William Zint, of Longines-Wittnauer Watch Company, presented a silver cigarette case with an early Bleriot monoplane picture in enamel.

Dr. A. F. Zahm compiled a set of papers on the Mattullath Airplane and the American Transit Company formed in 1900 to begin air transport. The inventor had some interesting ideas and established a wind tunnel at the Catholic University of America in Washington. The papers make an interesting addition to the Americana collection of the Archives.

J. Carlton Ward, Jr., President of the Fairchild Engine and Airplane Corporation, presented a model of the AT-14, Yankee Doodle.

Roger Wolfe Kahn presented a model of the Grumman Wildcat.

Several hundred other gifts were received, all of which were greatly appreciated.

First Air General

Lt. Gen. Henry H. Arnold, Commanding General of the Army Air Forces, was recently nominated by President Roosevelt to the four-star rank of full general, and the nomination was confirmed by the Senate. General Arnold is the fourth full general on active command duty in the United States Army and is the first officer of the Air Forces to achieve that rank.

General Arnold has been a flying officer since 1911, four years after his graduation from West Point. He was one of the first five Army officers trained to fly by the Wright Brothers and worked closely with General Mitchell for the development of the Army's air power. He is an Honorary Member of the Institute.

Gen. H. H. Arnold.

Edmund T. Allen Memorial Aeronautical Laboratories

A new high-speed wind-tunnel and aeronautical research laboratory that will provide facilities for carrying on the work of the late Edmund T. Allen, Boeing test pilot and scientist, is nearing completion. As a memorial to Allen and his ten associates who lost their lives in a bomber accident, the new research center will be named the Edmund T. Allen Memorial Aeronautical Laboratories. At the same time, it was announced that a suitable continuing memorial fund, in addition to the memorial laboratories, will be established to perpetuate the memory of the Boeing men who have died in the performance of their duties.

The wind-tunnel and laboratory

Aeronautica in the Archives of the Institute of the Aeronautical Sciences.

Upper left, medals and medallions. *Upper right*, glass and china boxes. *Center left*, rare models. *Center right*, General Maitland china set. *Lower left*, Americana. *Lower left*, relics, curios, china.

Maitland china

A FIFTH FREEDOM

To the four freedoms, will be added some day, a fifth freedom—*freedom of flight.* But it can't come till victory has assured the other four. Then . . . freedom to fly with safety, with economy, with comfort and convenience—will mean much to post-war peace and prosperity.

For post-war aircraft will measure trans-oceanic flights in hours, and can literally make all the world, good neighbors. Cities in near-by states will be less than an hour away, and the further development of the helicopter, will actually make *home-based* aircraft feasible and possible.

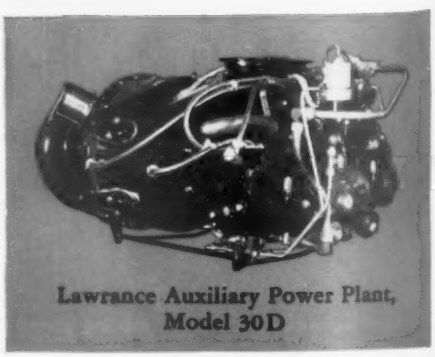
That's something to work for and plan for. But *right now* we've got something to fight for. We're glad that we, at McDonnell, can add our share to the gigantic contribution which America's aircraft industry is making to victory . . . and to the preservation of the four freedoms which are fundamental to democracy.

McDONNELL *Aircraft Corporation*

Manufacturers of PLANES · PARTS · PLASTICS ★ SAINT LOUIS-MEMPHIS ★

Down — but not out of action — is this long-range patrol bomber of the U. S. Navy. These aircraft, equipped with Lawrance Auxiliary Power Plants, possess a dependable source of electric power to operate radio, lights, and heating equipment even when main engines are dead — power to call for help and to keep the crew warm and comfortable until it arrives.

Lawrance Auxiliaries today serve America on the sea and in the air, providing power for accessory equipment of all kinds, from galley hot plate to main engine starters. The efficient and reliable performance of lightweight and compact Lawrance Auxiliary Power Plants is playing an important part in America's combat operations on world-wide battle fronts.



Lawrance Auxiliary Power Plant, Model 30D

Lawrance AUXILIARY POWER

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facilities were planned and developed under Allen's supervision as Boeing Director of Flight and Aerodynamics and incorporate many of his personal ideals and plans. They will provide a modern research center in which his staff will carry on the Allen system of painstaking research and development work that has resulted in many improvements in aircraft.

Although best known to the world as an outstanding test pilot, "Eddie" Allen will be remembered in aviation history for his scientific developments in aerodynamics. Allen's method of exhaustive, analytic flight testing, combined with an equally thoroughgoing program of wind-tunnel research and engineering study, has brought about many of the refinements that have made Boeing Flying Fortresses and other Boeing airplanes successful in their respective fields. His systematic approach has become not only a permanent working procedure of the Boeing Flight and Aerodynamics Division, but many of his methods have been studied and adopted by other aircraft companies as well.

A portion of the Allen Memorial Laboratories and adjacent offices will be occupied by Boeing aerodynamic research personnel, while the wind tunnel itself will be ready for use as soon as the specially designed and manufactured mechanical equipment can be installed. It is expected that it will be in service by midsummer.

New Corporate Members

During the past month the following companies have become affiliated with the Institute as Corporate Members:

Allis - Chalmers Manufacturing Company produces a wide variety of mechanical and electrical products which are used in practically every field of industry. The 1,600 lines of equipment manufactured by the company may be broadly classified into groups such as agricultural, industrial, marine, and aeronautical machinery, while other important classifications include equipment for public utilities, homes, road-building, and numerous special applications. For the aeronautical industries, the company supplies airport equipment such as tractors for moving and leveling earth and removing snow; vacuum and pressure pumps for factory operations, pumping coolants, and testing instruments; motors, motor-control devices, V-belt drives, unit substations and transformers, and other plant equipment; and arc welders of 5- to 75-amp. capacity for thin-gauge metals and intricate work.

Eastern Air Lines, Inc., has made great progress in the period from its initial service in 1928 to its present fleet of Douglas DC-3 airplanes and its network of scheduled flights. It was one of the first air lines to establish a medical department to keep its personnel constantly fit for duty and one of the first to test an automatic pilot. In technical research important work was accomplished in effecting improvements in aircraft ignition, oil economy, and maintenance procedures. Passenger comfort has been enhanced by better interior lighting of planes and by high-grade equipment and methods for serving hot food aloft. The company has worked closely with aircraft manufacturers for the improvement of air-line equipment and is current engaged in a study of the most efficient means for handling cargo for military and commercial purposes.

Part of the collection of pins and insignia at the Institute.

Sections and Branches

Detroit Section

The Detroit Section held a dinner meeting on December 3, 1942, at which time a review of several papers on aerodynamics from the Eleventh Annual Meeting were presented. The discussions were led by Profs. A. M. Kuethe and E. J. Lesher, of the University of Michigan, and Prof. G. Tweney, of the University of Detroit.

Academy of Aeronautics

At a meeting on February 10, 1943, two motion pictures were shown, *The Lathe* and *Plain Turning*, which show the operation and care of the lathe.

On February 15, papers were presented on "Cargo Planes" by Paul Bergeron and on "Weight Control" by Earl Fickett.

The election of officers was held on February 22: Chairman, Spencer Glanz; Vice-Chairman, George Cladis; Secretary, Nelson Davies; Treasurer, Charles Lach; Sergeant at Arms, Jack Brewster; Faculty Adviser, Milton F. Edwards.

On March 1, a paper on "Engine Mount Analysis by Descriptive Geometry and Mathematics" was given by Frank Bundschuh, Jr. This paper was selected for the Institute of the Aeronautical Sciences Student Branch Lecture Award. The Institute of the Aeronautical Sciences Student Branch Scholastic Award was presented to Bert Lesser for having the highest scholastic record during the Third and Fourth terms.

The Senior Dinner and Dance in honor of the graduating Seniors was held in the Hotel Lincoln on Friday evening, March 19.

The Aeronautical University

The Branch has completed final plans for its contest on technical papers for which about $30 in prizes will be given.

Robert Stebley has been appointed Honorary Chairman, succeeding Mr. Reed, and Mr. Sims, Dean of Engineering, will assist him.

Oklahoma A. & M. College

At a meeting on February 9, Robert Wattson was elected Chairman; at

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● Those four words often spell the difference between success and failure. When experts solemnly declare "You can't do **THAT!**" many people "fold their tents as the Arabs and silently steal away." But to the Spriesch Tool & Manufacturing Co., Inc. it's a challenge—a challenge to our ingenuity.

● The entire Spriesch organization prides itself on doing the impossible. It matters not whether the problem involves a single mechanical part or a complete assembly. No job is too small—none too large. We are equipped to do the tooling or go into production on the complete assembly. And the job will be done quickly and at reasonable cost.

● That's why Spriesch today is working 24 hours a day, seven days a week producing aircraft armament devices—automatic bomb-release racks and shackles, etc.—and producing them on schedule with a remarkably low percentage of rejections. We're flattered to hear it spoken of as Spriesch miracle war production.

● After Victory our extensive facilities will be available to you—no matter what your mechanical production problem may be. If you have need of special tooling, if you'd like to put an inventor's dream into production, if you have precision work you can't get in your own plant—make a note to submit it to us....

After Victory

Meanwhile, to acquaint you with our facilities and spirit, write (on your business letterhead, please) for our brochure "Ingenuity." It will give you a comprehensive view of what we have to offer.

Joseph J. Cheney
President

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and extensive facilities to produce intricate or simple designs—experimental pieces or mass production—complete assemblies or parts

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AD NO. 15

the meeting on March 9 George Hauggie was elected Vice-Chairman to replace Blaine Blakestad, and R. E. Roach was elected Secretary to succeed Ray Porter.

Changes were made in the By-Laws as proposed by the By-Laws Committee providing for modifications in the method of accounting for equipment and funds.

University of Oklahoma

The Oklahoma Student Branch has been working closely with the Tau Omega Fraternity, the national honorary aeronautical engineering fraternity. Joint meetings have been held, and at a dinner on March 3 Major Alexander P. de Seversky was made an honorary member of the fraternity.

News of I.Ae.S. Members

Howard H. Ash was appointed Group Leader of the Vultee Aircraft, Inc., Nashville Division.

Howard W. Barlow, Professor and Head of the Department of Aeronautical Engineering at the A. & M. College of Texas, was recently elected National Chairman of the Society of Aeronautical Weight Engineers.

Martin E. Barzelay, formerly with Pratt, Read & Company, Inc., has joined the Aircraft Engineering Branch of the Civil Aeronautics Administration as Associate Aeronautical Engineer.

William B. Beckwith is now in charge of the Meteorology Department of the United Air Lines Training Center.

Rex B. Beisel is the Engineering Manager at the Chance Vought Aircraft Division of United Aircraft Corporation.

Ralph P. Bielat has been promoted to Assistant Aeronautical Engineer at the Langley Memorial Aeronautical Laboratory of the N.A.C.A.

Walter Brandle, formerly a checker at The Glenn L. Martin Company, has entered the U.S. Army Air Forces.

Stuart W. Campbell is now in the U.S. Army Air Forces as an Aviation Cadet.

Alexander Cherwony has been accepted as an Aviation Cadet in the U.S. Army Air Forces.

Millford E. Collins, a Lieutenant in the Naval Reserve, is Officer in Charge of the U.S. Naval Flight Preparatory School.

Richard H. Depew is the new Manager of Special Projects at the Fairchild Aircraft Division of Fairchild Engine and Airplane Corporation.

Cleo. Deregibus, formerly with the United Aircraft Corporation, has joined the Eastern Division of the Pan American Airways System.

Ralph J. Doty has taken leave of absence to enter the U.S. Army Air Forces.

Jean H. DuBuque became Assistant Director of Pilot Training at the Airlines War Training Institute.

Carl H. Gelin joined the De Kalb Division of Interstate Aircraft & Engineering Corporation, having formerly been instructor at the Curtiss-Wright Technical Institute.

Robert D. Gilson, formerly engineer with The Glenn L. Martin Company, has transferred his activities to the General Motors Corporation.

Melvin S. Goldberger has entered the U.S. Army Air Forces after a term with the United Aircraft Corporation.

Archibald M. Hall is now Division Manager at the Allentown Division of Vultee Aircraft, Inc.

Harold E. Hartney was recently appointed Consultant at U.N. Planning & Development Corporation, Washington, D.C.

Joseph T. Hartson, Executive Vice-President of The Glenn L. Martin Company, was made a member of the Executive Committee of the Aeronautical Chamber of Commerce of America, Inc.

Roy M. Houck is now with North American Aviation, Inc.

Jacque Houser has been appointed a Teaching Fellow in Aeronautical Engineering at the University of Michigan.

Charles S. Jones, President of the Casey Jones School of Aeronautics, is one of the three new Vice-Presidents of the Aeronautical Chamber of Commerce of America, Inc.

Everett L. Kelly was commissioned a Lieutenant Commander in the U.S. Naval Reserve and was assigned to duty as an Aviation Psychologist.

Lee R. Malmsten has entered the War Training Service of the Civil Aeronautics Administration.

Charles Marcus, Vice-President of the Bendix Aviation Corporation, was elected a member of the Executive Committee of the Aeronautical Chamber of Commerce of America, Inc.

Bruno Kotowski was recently appointed Liaison Engineer at the Timm Aircraft Company.

Frank S. Mayer, Jr., is now a Stress Analyst in the Fort Worth Division of Hughes Aircraft Company.

Arthur L. McCullough has been commissioned a Major in the U.S. Army Air Forces.

Eugene Migotsky has been promoted from Junior Aeronautical Engineer to Assistant Aeronautical Engineer at the Langley Memorial Aeronautical Laboratory of the N.A.C.A.

William H. Miller has received his commission as Commander in the U.S. Naval Reserve. He was formerly an Aeronautical Engineer with the Bureau of Aeronautics in the Navy Department.

Herbert R. Pass, formerly Junior Aeronautical Engineer at the Langley Memorial Aeronautical Laboratory of the N.A.C.A., is now Senior Aerodynamicist at the Hughes Aircraft Company.

Robert T. Pollack is on leave of absence from Consolidated Aircraft Corporation to become an Aviation Cadet in the U.S. Army Air Forces.

Sanford E. Schubiner, formerly Vice-President and Chief Pilot at Holderman Air Service, Inc., has joined the Airplane Division of Curtiss-Wright Corporation as Test Pilot.

Walter A. Semion is now a Project Engineer with Higgins Aircraft, Inc.

James N. Smith has joined the Naval Research Laboratory at Anacostia, D.C.

John S. Smith, Vice-President of the Jacobs Aircraft Engine Company, is one of the new vice-presidents of the Aeronautical Chamber of Commerce of America, Inc.

Isaac A. Stanton, III, was recently appointed Engineer of the Pan American Airways System.

John R. Stiles has recently joined Willys-Overland Motors, Inc., as a Hydraulic Engineer in the Tool Engineering Division.

Matthew Sylvan is Production Manager at The Strickland Aircraft Corporation.

Leonard Troy, formerly Stress Analyst and Design Engineer at the Brewster Aeronautical Corporation, has joined The Strickland Aircraft Corporation.

Nathan F. Vanderlipp has been appointed Manager of Canadian Vickers, Ltd.

Milton F. Veck is Supervisor of Service Engineering at the Louisville Plant of Curtiss-Wright Corporation.

J. Carlton Ward, Jr., President of Fairchild Engine and Airplane Corporation, was elected a Vice-President of the Aeronautical Chamber of Commerce of America, Inc.

George T. Willey has been elected Vice-President and General Manager of The Glenn L. Martin-Nebraska Company.

Members Elected

The following applicants for membership or applicants for change of previous grade have been admitted to membership in the grades indicated since the publication of the list in the last issue of the REVIEW.

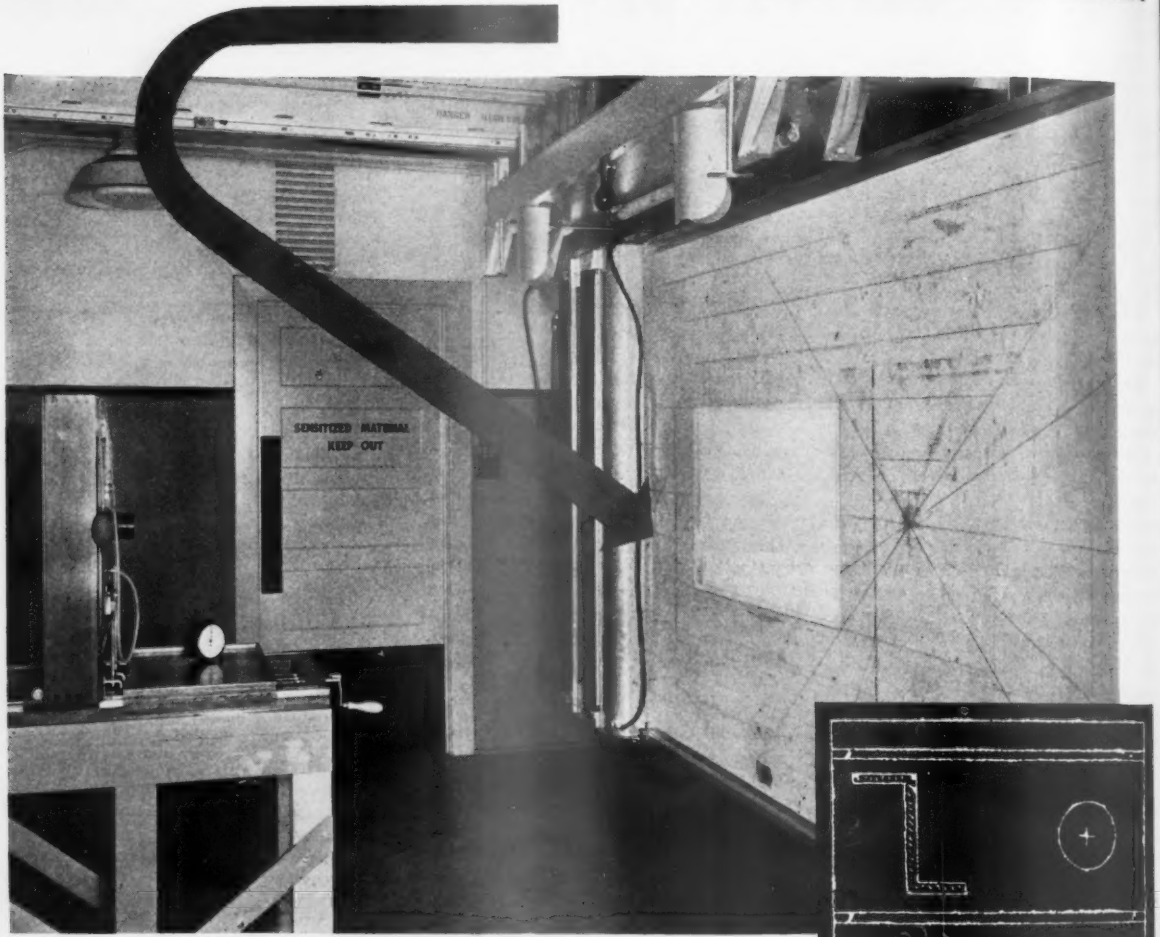
Transferred to Associate Fellow Grade

Kendrick, James Benjamin, M.S. in A.E.; Chief Aerodynamics & Flight Test Engineer, Vega Aircraft Corp.

Wendt, Robert Herbert, Chief Engineer, Taylorcraft Aviation Corp.

Wolf, Robert A., M.S. in Ae.E.; Chief Research Engineer, Bell Aircraft Corp.

HERE'S YOUR METAL FOR TEMPLATE WORK!



Today's faster and truer methods of reproducing aircraft templates demand master sheet metal patterns that have a smooth, durable surface.

Such a metal is ARMCO Galvanized PAINTGRIP—the original mill *bonderized* sheet for taking and holding paint. Designers in many warplane plants know from experience that scribed lines on a PAINTGRIP sheet won't fade or flake in electrolytic or photo-loft work. The coating on this special-purpose metal retains its sharp, clean-cut appearance in copy after copy.

Here are six reasons why ARMCO PAINTGRIP is used for template work:

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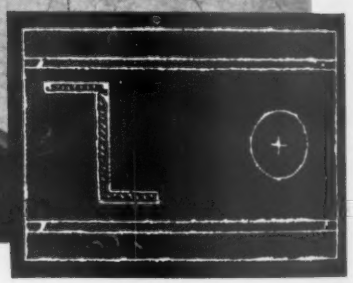
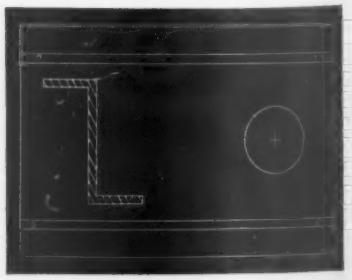


TOP: Note how paint film flakes from lines on ordinary steel. *BOTTOM:* No flaking or peeling on this PAINTGRIP sheet.



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Craigon, Adams, President & Chief Engineer, International Aeronautical Corp. Ltd., Canada.

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Duncan, Ian Gair, Special Appointment, Ministry of Aircraft Production, England.

Dunford, Edward Frank Barry, Design Engineer, Noorduyn Aviation Ltd., Canada.

Gladwin, Harold Sterling, Jr., Engineering Representative, Liaison Committee, Boeing Aircraft Co.

Glenn, Richard Vernon, Captain, U.S. Army Air Forces.

Gregory, H. Franklin, A.B.; Chief Miscellaneous Aircraft Projects, Materiel Center, U.S. Army Air Forces.

Hartwick, Ralph Niemeyer, Asst. Project Engineer, Consolidated Aircraft Corp.

Jeppesen, Gordon Lutz, M.S. in C.E.; Chief Stress Analyst, Goodyear Aircraft Corp.

Johns, Winthrop Asa, B.S. in M.E.; Head, Experimental Dept., Atlantic Diesel Corp.

Kinnard, Isaac Fern, B.S.; Executive Engineer, General Electric Co.

Kosko, Eryk, Engineer in Charge of Aero. Engineering, Aircraft Div., Canadian Car & Foundry Co. Ltd., Canada.

Lehecka, Emil Anthony, Test Pilot, Gould Aero. Div., Pratt, Read & Co., Inc.

Lerom, John Iver, LL.B.; Aero. Inspector, C.A.A.

Limage, James Stilson, B.A.Sc.; Chief of Structural Engineering, Bell Aircraft Corp.

Lissner, Herbert R., M.S.; Instructor, College of Engineering, Wayne University.

MacFadden, George William, Development Engineer, Virginia Lincoln Corp.

Marschner, Charles F., B.S. in Ae.E.; Manager, Plastics Div., McDonnell Aircraft Corp.

Normandin, Victor, Capt. & Engineer, Chilean Air Force, Chilean Government.

Nycum, John Franklin, B.S. in Ae.E.; Chief Engineer, Delta Air Corp.

Pelletier, Emile J., B.S.; Asst. Engineer & Manager, Bell Aircraft Corp.

Pond, Benham Sackett, Asst. Chief Engineer, The Acrotorque Co.

Salvadori, Bruno Joseph, B.S. in M.E.; Chief of Structures, Bellanca Aircraft Corp.

Savage, Charles F., B.S.; Engineer, General Electric Co.

Spengler, Walter Jacob, E.E.; Executive Engineer, Scintilla Magneto Div., Bendix Aviation Corp.

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Greenwood, Marvin H., M.S. in M.E.; Preliminary Design Engineer, Boeing Aircraft Co.

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Hoff, William Charles, Asst. Editor, William H. Wise & Co.

Redding, William Preuette, B.S.; Executive Vice-President, N.A.A.

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Bollinger, Henry William, Sr., Layout Draftsman, Vultee Aircraft, Inc.

Brown, Emery Burnham, Liaison Engineer, United Aircraft Corp.

Carpenter, Edward Griffen, B.S. in M.E.; In Charge of Static Test Lab., Bell Aircraft Corp.

Cherkas, Paul, Detail Draftsman, United Aircraft Corp.

Crosman, Alex. Cameron, B.S.; Tool Designer, Briggs Manufacturing Co.

Dobrin, Solomon, M.A.; Instructor, Casey Jones School of Aeronautics.

Ehmcke, William Knox, B.S. in M.E.; Planning Flight Tests, Consolidated Aircraft Corp.

Elmiger, Frank W., Jr., Instructor, Academy of Aeronautics.

Gowan, William H., Jr., Aero. Test Engineer, De-Icer Div., The B. F. Goodrich Co.

Gunst, Morgan A., Jr., B.S.; Production Engineer, Lockheed Aircraft Corp.

Jesse, Ferdinand Leopold, Asst. Group Leader, Fixed Equipment Design Group, Engineering Dept., Bell Aircraft Corp.

Jossen, Harvey Frederic, A.B.; Instructor, Army Air Forces Technical Training Command.

Kaser, Robert A., Technical Director, Commonwealth Engineering Co.

Knopf, George S., B.S. in Ae.E.; Engineer, General Motors Corp.

Kopacki, John J., Tool Designer, Bell Aircraft Corp.

Lammers, Alvin Floyd, Power Plant Engineer, Boeing Airplane Co.

Landis, Raymond Bruce, Engineering Draftsman, Kellett Autogiro Corp.

Mateer, Warren D., A.B.; Research Co-ordinator, Research Lab., Curtiss-Wright Corp.

Parks, John Lee, B.A.; Jr. Stress Analyst, The Glenn L. Martin Co.

Peters, Wesley H., Group Engineer, Goodyear Aircraft Corp.

Ranish, Harry, B.A.; Aircraft Electrician, U.S. Army Air Forces.

Raser, William Heyl, Jr., B.S. in E.E.; Research Engineer, Propeller Div., Curtiss-Wright Corp.

Rueckert, Charles E., B.S.; Jr. Engineer, Goodyear Aircraft Corp.

Ryan, Jerome Andrew, B.S. in A.E.; Flight Test Engineer, The Glenn L. Martin Co.

Slater, Alfred Leon, M.S. in Ae.E.; Flight Test Analysis Engineer, Douglas Aircraft Co., Inc.

Stevens, William Thomas, Sr. Instructor, Army Engine Shop, The Aeronautical University, Inc.

Taylor, Evarts, Jr., B.S.; Jr. Aircraft Maintenance Supervisor, Air Service Command, War Dept., U.S. Army Air Forces.

Wendt, Ralph Edson, B.M.E.; Research Aerodynamicist, Bell Aircraft Corp.

Wilson, Robert Grant, B.S.; Stress Analyst, Vultee Aircraft, Inc.

Winborn, Byron Rufus, Jr., Lt. (j.g.), Aviation Volunteer Specialist, U.S. Naval Reserve.

Transferred from Student to Technical Member Grade

Amstead, Billy Howard, B.S.; Production Engineer, Mission Manufacturing Co.

Adams, Richard Edward, B.S. in M.E.; Engineering Asst., Lockheed Aircraft Corp.

Bellesheim, Joseph, Jr., Apprentice Engineer, American Airlines, Inc.

Blair, Morgan McCormack, B.S. in M.E.; Aviation Cadet, U.S. Army Air Forces.

Blom Trygve, B.S. in Ae.E.; Cadet Officer, U.S. Army Air Forces.

Brandau, Frederick Ludwig, B.S. in M.E.; Engineer, Lockheed Aircraft Corp.

Bundschuh, Frank John, Jr., Trainee, The Glenn L. Martin Co.

Bussing, Paul Richard, B.S. in M.E.; Jr. Flight Test Engineer, Chance Vought Aircraft Div., United Aircraft Corp.

Christophersen, Don Robert, B.S. in A.E.; Jr. Engineer, Ames Aero Lab., N.A.C.A.

Cochran, William John, S.B. in Ae.E.; Officer's Candidate School, U.S. Army Air Forces.

Danforth, Edward Courtney Bullock, III, B.A.E.; Jr. Aero. Engineer, Langley Mem. Aero. Lab., N.A.C.A.

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Goppert, Jean Glen, B.S. in Ae.E.; Corporal, U.S. Army Air Forces.

Gratiot, John Peter, B.S. in Ae.E.; Test Engineer, Mass. Inst. of Tech.

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Monts, Louis Frank, M.E.; Airplane Div., Curtiss-Wright Corp.

Perry, Felix Anthony, B.Ae.E.; Aircraft Project Engineer, Northwest Airlines, Inc.

Pettibone, Kenneth Porter, B.S. in Ae.E.; Stress Engineer, Ford Motor Co.

Preisick, G. Roger, B.S. in Ae.; Stress Analyst, Fairchild Aircraft Div., Fairchild Engine and Airplane Corp.

Skopinski, Ted Harry, B.S. in Ae.E.; Jr. Stress Engineer, The Glenn L. Martin-Nebraska Co.

Stevensen, Edward Nicholas, Jr., B.Ae.E.; Jr. Liaison Engineer, Airplane Div., Curtiss-Wright Corp.

Tabaka, Frederick William, B.Ae.E.; Meteorologist, American Airlines de Mexico, S.A.

Tower, Robert Louis, B.S. in Ae.E.; Jr. Engineer, Boeing Aircraft Co.

Turner, Robert Harris, B.S. in M.E.; Aerodynamicist, Fleetwings, Inc.

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Clerk, Jack Charles, Instructor, U.S. Army Air Forces.

Curry, James, Flight Sergeant, Royal Australian Air Force.

Goldman, Alfred Mynderse, Inspector, B-24 Final Assembly, Consolidated Aircraft Co.

Grochowski Mitchell, Tool Engineer, Aircraft Div., Packard Motor Car Co.

Larsen, Spencer A., D.Sc.; Assoc. Prof. of Business Administration, Wayne University.

Lawrence, John Denard, Jr., Major Layout Draftsman, Consolidated Aircraft Corp.

Lundeen, Edward Bernard, Draftsman, Consolidated Aircraft Co.

Robins, Samuel David, B.S.; Consultant, Hopkinson Laboratories, Inc.

Witek, Edward, Engineering Leadman, Consolidated Aircraft Corp.

y Urrutia, Victor Gil, Pilot, Cia. Aeronautical Del Sur, S.A.

Necrology

Edward Whitman Morris

Edward W. Morris died on February 13, 1943, in Dayton, O. He was born in Massachusetts on July 19, 1909.

Mr. Morris was graduated from Dartmouth College in 1931 with a B.A. degree, majoring in physics, and in 1933 he received a B.S. degree in Aeronautical Engineering from the Massachusetts Institute of Technology. He was employed as an Aircraft Engineer by the Curtiss Aeroplane & Motor Company and transferred to the propeller department within a year.

In the fall of 1934 Mr. Morris became an Instructor and Research Assistant in the aircraft engine laboratory at Mass. Inst. of Tech. In February, 1936, he returned to the Curtiss Buffalo Plant as an engineer in the propeller department. When that department expanded to form the Curtiss Propeller Division at Clifton, N.J., Mr. Morris was appointed Assistant Chief Engineer there.

In June, 1940, he joined the newly formed Aeroproducts Division of General Motors Corporation at Dayton and was made Assistant Chief Engineer, which position he occupied at the time of his death. He was in charge of all blade developments for the Division.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

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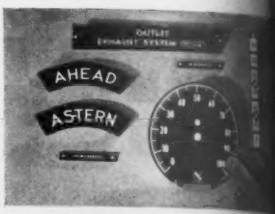
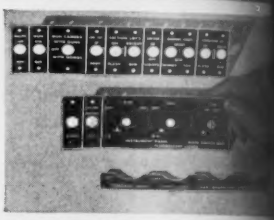
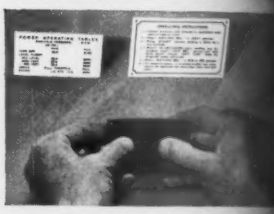


2 FLUORESCENT Sharp reproduction of fine detailis obtained with any of the fluorescent materials. They become an integral part of the sheet—not just a surface coat—and thus cannot chip or rub off during installation or in service.



3 FLEXIBLE—This semi-rigid sheet material is suitable for instruction or identification panels which must be attached to curved surfaces of equipment—or where serial numbers or other markings must be cold-stamped on the finished material.



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